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Addressing Fundamental Behavioural and Welfare
issues associated with Zoo Housed Animals: Using
Lowland Tapirs *Tapirus terrestris* and Giraffes
***Giraffa camelopardalis* as Model Species**

By

Anouska Ann Kinahan

This thesis is submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy to Trinity College, University of Dublin

Department of Zoology

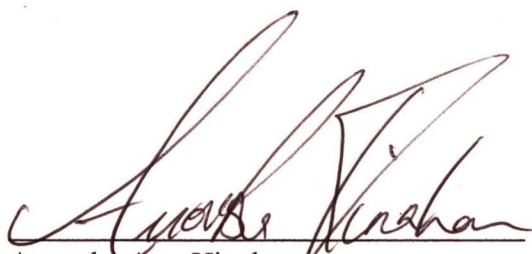
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DECLARATION

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Anouska Ann Kinahan

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Chapter One

INTRODUCTION

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Chapter One

INTRODUCTION

1.1 *The Changing Role of Zoos*

Zoos, living museums and menageries have been around since early Egyptian and Roman times. Throughout the ages zoos have developed a more important role than merely exhibits. Nowadays, zoos serve a major role in research, conservation and education. As well as zoos themselves changing their function, public perception of zoos has also changed. Due to various wildlife documentaries and the increasing awareness of the continuous destruction to habitat and populations, people are no longer satisfied with seeing wild animals caged in barren and sterile conditions. Increasing knowledge about behaviour also causes concern to the public about the welfare of the animals in captivity (Balmford *et al.* 1995).

So why has this change come about or indeed, why did it take so long? In the past, curators of zoos were not scientists and were not obliged to do research. Their primary goal was orientated towards taxonomy and acquisition (Benirschke 1996). This is now changing and many curators of zoos do have a scientific background. Previous zoo managers were mainly concerned with husbandry and management budgets and did not include provision of funds towards research. Now that research is becoming an

increasingly important issue amongst zoos, these provisions are being made, for example Dublin Zoo allocates 2.5% of its budget to research. Earlier zoos had a continuous cycle of obtaining new exotic animals from the wild to replace the ones that had died. Taking animals from the wild was faster and less expensive than the acquisition of detailed biological knowledge necessary for successful animal management. However, as time went on e.g. from the 1960's on, a decrease in wild populations led to limitations on continuous acquisitions. New conventions e.g. CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) also made purchase difficult by governing traffic in many species and often prohibited new acquisitions. CITES became effective from May 1977 internationally. Furthermore, social and political unrest in countries housing exotic species, along with a decrease in the number of trappers made animal acquisition difficult (Benirschke 1996). This led to zoos now having to continue to learn and understand how animals could be bred and sustained in captivity and opened up a new need for research in zoos.

1.2 *Development of Research in Zoos*

As wild populations and habitats shrink, zoos are becoming the only refuge for many species (Benirschke 1996). As a consequence, zoos must now orient themselves to becoming international conservation centres (Raab 1994). This means that research into many aspects of the animals' physiological and behavioural biology must be considered an important issue. With this innovative role for zoos, new changes have begun to come about.

Before the 1960's, very little about the genetic makeup of wild animals was known. Zoo managers were often unable to avoid the effects of inbreeding in captive populations (Rawlins 1985). The first step to improve this was the creation of studbooks. Studbooks are kept at all zoos for the majority of species. Studbooks provide information about individuals such as their genetic histories, medical history and various husbandry guidelines for particular species. Studbooks make it safer for species to be swapped and sold to other zoos by cross - referencing and ensuring that related animals are not bred together.

However, the first life science discipline to make an impact on zoos was veterinary medicine. In the 1950's many zoo animals were diseased and illness could only be diagnosed and cured if the animals could be handled and treated. The most satisfactory way to do this was to introduce sedation and tranquillising techniques (Brambell 1993). The next important discipline to become involved in zoo animals, concerned nutrition and dietary techniques to ensure healthy stock (Kuhn 1964). Then came behavioural studies and modern techniques such as genetics (Seuanez *et al.* 1976), parasitology (Heuschele *et al.* 1984), physiology (Finlay & Maple 1986) and biotechnology (Lasely & Anderson 1991).

1.3 *The Need for Research in Zoos*

Many species are faced with huge habitat destruction, over-poaching, ineffective protection and quite often, even protected areas set aside for conservation are endangered through war (Balmford *et al.* 1995). To date, the World Conservation Union

(IUCN) identifies the number of all threatened taxa at greater than 5,000. However, this number merely represents taxa that are known to the IUCN. It is thought that over the last 400 years some 490 species have become extinct (World Conservation Monitoring Centre 1992). Again this number is merely a representation of known species and continues to rise at a rapid rate. Meyers (1993), recognises this major problem many species are facing and indeed reiterates the importance of scientific input in the restoration of this problem. He suggests that this is,

“..an opening phase of mass extinction, one with scope apparently to eliminate anywhere between 1/4 to 1/2 of all species in the foreseeable future, we need to devise conservation responses which have the maximum capacity to stem the biotic holocaust, in so far as this is still possible.”

And that

“...at the same time we should recognise that such a challenge places a premium on a thorough scientific understanding of all issues involved”.

(Meyers 1993).

Recognising the lack of time and the limited resources available to zoos, the importance of strategic collection planning on a global, regional and institutional level is extremely important to the success of the World Zoo Conservation Strategy. Zoo conservation efforts must be integrated with other conservation bodies and to the interactive management of wild and captive breeding populations (Mallinson 1994). One of the most forcefully advocated approaches for addressing this problem is wide spread *in situ* and *ex situ* conservation whereby sizeable populations of threatened

species are established and maintained in captivity until eventual reintroduction is possible (Soule 1987). It was for these reasons that, in 1964 the first international meeting on the subject of zoos and conservation took place and hence, captive breeding became a major goal from then onwards (Rawlins 1985).

Genetic studies in captive animals are important when there are plans for breeding. Breeding individuals with chromosomal divergence could have serious consequences (Seuanez *et al.* 1976). The genetics of wild animals should be studied prior to establishing breeding programmes for captive species. This could then prevent breeding between sub-species producing hybrids as in the case of many captive giraffes *Giraffa camelopardalis* (See Chapter 3, Section 3.2.2).

When animals are kept together, disease can often spread rapidly. One example which demonstrates the need for parasitological studies in captivity can be seen in the case of malignant catarrhal fever. This fever has caused huge problems for captive ungulates in zoos. It is thought to originate from infected gnus *Connochaetes spp.* (Heuschele *et al.* 1984). Studies such as this one enable disease-causing parasites to be identified and hence, eliminated.

Modern reproductive techniques have benefited humans and domestic animals, such as embryo transferral; the use of surrogate mothers etc. (Lasley & Anderson 1991). Successful manipulation of infertile animals with modern technologies such as the use of GnRH (Gonadatrophic Reproductive Hormone) in reptiles (Philips *et al.* 1985), demonstrates that perhaps techniques such as embryo transfer have a place in the conservation of exotic zoo animals in the near future. With this new knowledge iguana species, which were once rarely able to breed after importation, are now successfully bred in captivity (Philips *et al.* 1985).

The recent progress many zoos have made in breeding endangered species and establishing self-sustaining populations must be commended. These advances show that captive breeding programmes can not only prevent the loss of wild populations but also provide a means of maintaining genetic diversity (Mace & Foose 1986). However, despite efforts being successful, as yet the actual number of species which have been saved by captive breeding programmes is relatively small, with only around 25 species having been preserved in captivity and reintroduced following extinction in the wild (Magin *et al.* 1994). Some examples of these "saved" species include -: The European bison *Bison bonasus* (Flesness & Foose 1990); the Arabian oryx *Oryx leucoryx* (Stanley-Price 1989); the black footed ferret *Mustela nigripes* (Miller *et al.* 1994) and the Californina condor *Gynopyps californianus* (Toone & Wallace 1994).

Behavioural studies are amongst the most popular areas of research in zoos. This may be attributed to such factors such as its non-invasive method of data collection and the lower cost than lab based research. Captive breeding often fails as a result of behavioural problems (Synder *et al.* 1996). Since behaviour is a consequence of interactions between both genetic and environmental factors, failure to reproduce an environment that is at least functionally equivalent to that of the wild, will often result in the loss of many forms and patterns of natural behaviour (Sheperdson 1994). Nowadays, behavioural issues are widely accepted as important in the management of captive species (Gibbons *et al.* 1995). The success of release programmes of captive bred or translocated animals also depends to a large extent upon their behavioural skills (Sutherland 1998). Initial releases of captive bred golden lion tamarins *Leontopitecus rosalia rosalia*, showed that the tamarins lacked the ability to recognise food or predators in the wild and even lacked basic locomotory skills (Beck *et al.* 1994). However,

subsequent studies using enrichment to “train” the tamarins in certain skills, appeared to be more successful and hence they were successfully reintroduced. There is a need for reintroduced animals to acquire these and other species-specific skills. Animals being re-released into the wild need to know how to forage or hunt for food and mates, protect their territory, live successfully in a social group (if they are social animals) and know how to protect themselves and their young. Many species have their own species-unique way of locating food, avoiding predators etc, and for this reason it is imperative that reintroduced species know how to survive in their native regions, performing their necessary behaviours. Rufus hare-wallabies *Lagorchestes hirsutus* were successfully trained to recognise predators by squirting them with water pistols whenever a stuffed predator on a trolley was pulled across the cage from a box (McLean *et al.* 1994).

Along with behavioural studies toward the mid 20th century, came an increasing awareness and concern over animal welfare in zoos. There was a need for the animals to be provided not only with their physical needs i.e. food, shelter etc., but their behavioural needs as well. In fact, Articles III, IV and V of the European Convention for the Protection of Animals kept for Farming Purposes state that provision must be made not only for the animals’ physiological needs but for the animals’ ethological needs as well (Dawkins 1983).

1.4 *Animal Welfare*

Animal welfare is an ever-growing concern amongst many people: scientists,

zoo personnel and the general public. In studies and research about animal welfare there is discrepancy as to what welfare actually means and how can it be assessed. Some scientists equate welfare with biological fitness, suggesting that welfare is only reduced if the animal's ability to survive and reproduce is diminished (Barnett & Hemsworth 1990). Fraser and Broom (1990) described some commonly used indicators of poor welfare such as, gastric ulceration, poor functioning of the immune system, reduced fertility, apathy, stereotypy and infanticide. Later on Broom (1991) reiterated that physical condition is important for welfare, but that welfare may also be poor even when physical suffering does not occur. This supports other claims that feelings are of paramount importance and welfare is only at risk if the animal is subjected to experiencing unpleasant mental states (Dawkins 1980). These unpleasant mental states may be fear, anxiousness, frustration, boredom etc (Morris 1964). This view implies that despite an illness which may be potentially detrimental to an animals fitness, unless this illness is associated with an unpleasant cognitive state, it would not be considered as causing suffering or reducing welfare (Duncan & Petherick 1989).

Suffering and welfare are often coupled together, but the two do not necessarily coincide. For example, if an animal is sleeping, it can be said that because cognitively the animal can not feel the pain, the animal is not suffering. However, just because the animal is not suffering at a particular time, it does not necessarily mean the welfare of the animal is not still in jeopardy. This disagrees with Duncan & Petherick's (1989) concept that unless the animal is harbouring an unpleasant cognitive state, the animal cannot be considered suffering or in poor welfare.

Another major problem associated with animal welfare is how it can be measured. One method is by measuring various physiological parameters which appear

to correlate with stress levels, such as steroid levels in blood. Steroid levels are known to be associated with stress as they are secreted in stressful situations such as physical injury (Cannon 1929). Corticosteroids such as cortisol feature predominantly in animal welfare research. Levels of these hormones rise in many situations that probably indicate poor welfare or suffering (Mason 1971; Lundberg & Forsmann 1979). Barnett *et al.* (1987) discovered that elevated cortisol levels in tethered sows revealed unresolved aggression between neighbours, therefore indicating a need to redesign their housing conditions.

Another hormone used in assessing welfare is prolactin. Raised levels of prolactin were found to occur in depressed people and anxious students awaiting exams (Herbert 1987).

However, there are a number of problems associated with using physiological responses as a welfare indicator.

- (i) It is unclear what levels of physiological changes actually indicate suffering
- (ii) Some physiological responses are similar to stress responses, such as excitement. Increases in adrenalin may indicate rises in anxiety or pleasurable experience.
- (iii) Different measures on the same animal can sometimes lead to contradictory results.
- (iv) Measuring relative welfare of animals in two sorts of environment may also produce incongruent results.
- (v) Measuring physiological responses often involves invasive techniques, which in themselves may compromise welfare.

For these reasons, the utilisation of physiological responses as measures of welfare may not be ideal (Mason & Mendl 1993).

The other main method to assess the welfare of an animal is to look at the animal's behaviour. Some behaviours are widely accepted as aversive behaviours. Excessive inactivity and sleep, over-grooming, aggression, over/under-eating, failure to breed and coprophagy are some of the behaviours which are thought to indicate poor welfare (Morris 1964). An advantage of behavioural techniques is the uninvasive methods by which data can be collected. However, a major problem is that the underlying cause of these problems can not always be resolved through behavioural observations alone.

Changes in hormone levels and/or frequency of certain behaviours do not in themselves represent suffering (Hughes 1980). What is important is whether changes that give rise to these conditions actually matter to the animal (Dawkins 1988). Suffering may be divided into two categories. The first is suffering caused by the presence of conditions or stimuli that an animal is motivated to avoid, but can not. Secondly, suffering may be caused by the absence of conditions or stimuli which would enable an animal to express a particular behaviour it was motivated to perform. Therefore, one way to assess how much an animal is suffering is to establish how strongly motivated an animal is to do something (Dawkins 1988).

1.5 Motivation

Motivation is a state of the nervous system. It is motivation that will determine the likelihood of an animal performing a particular behaviour (Jensen & Toates 1993). Mason *et al.* (1997), describe motivation as the link which lies between a variety of inputs with behavioural outputs and the way in which changes in these outputs occur. The concept of an animals' motivation to perform certain behaviour being "driven from within" or "instinct" was put forward by early ethologists such as Lorenz (1950). Lorenz put forward an energy model to explain the motivation of animals, which he called the "psychohydraulic model" of motivation (Lorenz 1950). This model suggests that if an animal went for a long time without performing a certain behaviour eventually nervous energy would build up, so that the behaviour would be more likely to occur. He argued that this energy can build up and thereby occur even in the absence of any appropriate stimuli, this phenomenon he called a "vacuum activity". Although this concept was revolutionary in its time, there are many problems associated with this theory to explain the motivation behind all behaviours.

Hinde (1960) was the first to lead an attack Lorenz's ideas of "drive" and "instinct". The model suggests a pent up physical energy, however instinctive energy alone does not power up the muscles to perform the behaviour, chemical energy does. Thus, instinctive energy should be defined as the sum of all internal causal factors e.g. hormones etc. existing at any one time (Slater 1985). Another problem the psychohydraulic model faces is that it implies that motivation remains high unless an

appropriate behaviour is performed. Hughes and Duncan (1988), support this implication and state that for any behaviour that is largely governed by internal factors, the motivation to perform these behaviours will reach a threshold eventually. In other words the longer the behaviour is prevented the more motivated the animal becomes to perform the behaviour.

Lorenz's model may be suitable to explain the motivation behind one sort of behaviour e.g. singing in songbirds, in which testosterone is a causal factor and the behaviour will occur in any environment if testosterone is present (Slater 1985). The model however, does fail to account for the motivation behind other behaviours. For example, in the absence of rivals an animal is not more likely to be motivated to fight (Archer 1988). Hence, if animals are motivated differently for different behaviours, it is plausible to assume that the consequences of an inability to carry out each behaviour may also differ (Bolles 1975).

So, with regards to captive animal management, the behaviours which an animal needs to perform and the consequences of the animals not being able to perform these behaviours, is an area which needs to be examined.

1.6 *Coping Behaviour*

Animals are highly adaptable, and often alter behavioural and other requirements to survive or 'cope' in a variety of environments. Fraser & Broom (1990), defined coping and the consequences of failing to do so as,

“..having control of mental and bodily stability. This control may be short lived or prolonged. Failure to be in control of a mental and bodily stability leads to reduced fitness”

(Fraser & Broom 1990).

Although animals perceive and probably feel the adversity of a stimulus, it is impossible to collect data on their emotions and the influence coping behaviour has on them (McFarland 1989; Bateson 1991). Coping behaviour is performed in aversive fitness-threatening situations and Wiepkema (1987) suggests that it is plausible to assume that the animal experiences negative feelings when exposed to such situations. However, this assumption fundamentally cannot be accepted as the subjective experiences of animals cannot be measured.

Wechsler (1995) describes four main coping strategies -: escape, remove, search and wait. Escape behaviour is an effective strategy to get rid of aversive stimuli by increasing the distance between the animal and the stimuli. Escape behaviour is adaptive as a stress reducing response, for example, of an animal faced with a challenge from a dominant peer (Moberg 1985). This behaviour can be successful in some cases such as rats learning to escape electric shocks by jumping onto a platform (Weiss 1968). Alternatively, despite efforts this behaviour may also be unsuccessful. When sows are tethered for the first time they try to escape by throwing themselves backward vigorously, but fail to escape due to restraints (Cronin *et al.* 1986). This is similar to many zoo animals when restrained for transport or veterinary purposes.

An alternative to escaping is to try and remove the stimulus itself. Korte *et al.* (1992), showed that rats push and kick bedding material over an electrified probe after receiving an electric shock.

If aversive conditions persist due to the absence of a stimulus, the animal may perform searching behaviour. This behaviour is regarded as an adaptive coping response or 'appetitive behaviour' (Craig 1918; Hughes & Duncan 1988). Appetitive behaviour is characterised by high levels of locomotory and exploratory behaviour that enhance the probability of finding an absent stimulus. It is often associated with frustrated feeding and drinking behaviour. McFarland (1965) experimented on Barbary doves *Streptopelia risoria*. After a period of water deprivation the doves pecked at grain, sand grain and faeces without swallowing them. With respect to coping behaviour this can be interpreted as appetitive testing for objects and rejecting them due to the lack of liquids the birds were looking for. These strategies are considered to be 'actively' coping approaches.

Actively coping strategies include a variety of ways to cope. Actively coping tree shrews when defeated in a fight, will withdraw from situations which could lead to more intense fights by active avoidance, but they will fight if faced with a dominant individual (von Holst 1985). Actively coping pigs resist vigorously and attempt to escape when restrained (Schouten & Wiepkema 1991).

If an animal is unable to use any of the above strategies, it is highly mal-adaptive for them to continue the activity wasting valuable energy. So, in this instance, it is more beneficial for the animal to conserve energy and wait for a spontaneous change in the adverse situation. This type of coping strategy in farm and lab animals has been called 'apathetic behaviour' or 'passive' coping. (Wiepkema *et al.* 1983).

Benus *et al.* (1987) argue that passively coping strategies are based on the possibility that the animal may remain undetected and eventually the source of the threat will leave the area itself. Passively coping animals react to adverse stimuli generally through immobility. Passively coping defeated tree shrews sit almost continually in the corner of their cage and accept threats and attacks of dominant animals without fleeing or defending themselves (von Holst 1985).

Dividing the four types of coping strategies into two major categories i.e. active and passive, it can be seen that the two categories show different physiological responses. Actively coping responses involve the activation of the sympathetic adrenomedullary system (Henry & Stephens 1977). Passively coping strategists require the activation of the pituitary adrenocortical system (von Holst 1975; Bohus *et al.* 1987). With respect to behavioural patterns it is only passively coping strategies which show consistent responses in different situations. Whether one strategy or the other is better adapted is debatable. Which one is chosen is largely dependant on the given situation and adverse stimuli. Bohus *et al.* (1987) showed that actively coping rats exhibited more exploratory behaviour than passive rats. However, Benus *et al.* (1987), observed that passively coping mice will start to explore a maze once they are taught to do so.

Serious welfare problems are likely to arise when an animal fails to change the adverse situation. Broom (1991), incorporated the idea of coping into the assessment of welfare.

“Welfare is poor when the individual has difficulty in coping with its environment.”

(Broom 1991)

Wechsler (1995), suggests that in order to prevent poor welfare, housing designs should allow provision to enable animals to perform effective coping behaviours when

confronted with aversive situations. Animals which are unable to perform these coping behaviours under some housing conditions may develop abnormal behaviours, hence many abnormal behaviours such as stereotypies seem to be closely related to thwarted coping behaviours (Cronin *et al.* 1984).

1.7 Stereotypies

Stereotypies may be defined as repetitive, invariant behaviours with no obvious goals or functions (Mason 1991). They appear to be restricted to captive animals, mentally ill or handicapped humans and subjects given stimulant drugs. Stereotypies contain certain elements of predictability in time and place of performance, as well as predictability in the physical action (Hediger 1950; Meyer-Holzapfel 1968; Hinde 1970). They are not necessarily environmentally induced, they can also be elicited by brain damage or psychiatric conditions (Ridley & Baker 1982); as time progresses they may occur even in the absence of the stimuli that may have encouraged them in the first instance (Levy 1994; Hinde 1970). Examples of stereotypies include repetitive vocalisations and rocking in humans (Stone 1964), bar chewing in stalled sows (Wiepkema *et al.* 1983), pacing in zoo animals (Odberg 1984), head swinging in Elephants (Dittrich 1984) and tongue playing in giraffes (Koene & Visser 1996).

Stereotypic behaviour has long been considered as an indicator of sub-optimal conditions and hence, poor welfare (Hediger 1950; Broom 1983; Odberg 1987). Some investigations show that stereotypic behaviour is associated with a reduction in physiological measures of stress and therefore, may in fact be a method of coping

(Wiepkema *et al.* 1987) (see section 1.6). An increase in stereotypic behaviour of rats sensitised to amphetamine was accompanied by a decrease in plasma corticosterone levels (Mittleman *et al.* 1991), which possibly indicates a reduction in stress levels. However, Terlouw *et al.* (1991) found no correlation between post-feeding stereotypic behaviour and plasma cortisol levels and no increase in cortisol levels when sows were prevented from performing bar chewing behaviour. This highlights once again some problems and discrepancies associated with using physiological responses as indicators.

Often stereotypic behaviour and coping strategies have been coupled together. Mason (1993) suggested that pacing movement in caged mink may stem from appetitive food-searching behaviour, whereas stationary stereotypies such as head twirling may be derived from escape attempts. Wechsler (1991) also suggested that stereotypic walking in captive polar bears may stem from appetitive behaviour. Cronin *et al.* (1984) described four stages in the development of stereotypies in sows tethered for the first time:-

- (i) resist and throw themselves backwards
- (ii) remain lying quietly for long periods
- (iii) perform short bouts of repetitive investigative behaviour
- (iv) develop individualistic patterns of stereotypic behaviour.

This pattern of behaviours can be regarded as a sequence of coping strategies,

- (i) escape
- (ii) wait
- (iii) search
- (iv) stereotype.

Despite stereotypies being associated with coping strategies, various other theories have suggested other factors to be the cause of stereotypies. Morris (1964) indicates that cage size plays a contributing factor to the onset of stereotypic behaviour, however, Ödberg (1984) found that complexity of environment rather than cage size was far more important. Other factors suggested to cause the onset of stereotypies include: proximity to the public, lack of novelty (Maple 1980), early rearing deprivation and isolation, overcrowding and lack of specific features such as a certain substrate (Stevenson 1983).

Although stereotypic behaviour is widely used as an indicator of poor welfare, Mason (1991) refers to many situations where stereotypies are found in situations where there are no signs of adverse conditions. Some evidence suggests that stereotypies possess reinforcing qualities may actually be rewarding the animal in a certain way, by relieving anxiety and increasing sensory input in an unstimulating environment (Fox 1965). Morris (1964) thought that stereotypic pacing may be a substitute for patrolling a territory. The behaviour introduces novelty and increases stimulus levels, hence, may be a way of coping in a restricted environment. Fox (1971) describes pacing beside parallel bars as rewarding with the resultant flickering light stimulating the animal and Mason (1991) suggests that oral stereotypies such as tongue playing in giraffes may be a substitution for normal consummatory activity.

Additionally, the fact that some stereotypies develop over a period of time (Meyer-Holzapfel 1968), are persistent once developed, and it is difficult to deter the animals from performing the behaviours (Dawkins 1990), suggest qualities which are consistent with reinforcement (Duncan & Woodgush 1972).

Stereotypic behaviour is often classified as a behaviour with no obvious goal or function, however some nonstereotypic behaviours can also be devoid of functional consequences. Examples are habits in humans, which are relatively independent of the current value of their original goal (Dickinson 1985). However, it can be debated as to whether habits may be classified as stereotypies or not.

Finally, pacing is abnormal in context and frequency compared to the wild behaviour of the same species. However, the motor patterns are similar to those shown in the wild, therefore, the animal may be increasing muscle tone and hence overall general health status (Veasey *et al.* 1996)

The studies above show a variety of results, indicating that perhaps when considering stereotypic behaviour, each behaviour should be examined individually and therefore, we should not assume a general rule for all types of stereotypies.

1.8 *Enrichment*

Environmental enrichment is defined as:-

“an animal husbandry technique that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for the optimal psychological and physiological well-being”

(Shepherdson 1998).

Environmental enrichment provides the animals with the facilities (either through modification of their environment or management), so that the animals can be given

the opportunity to perform a variety of behaviours that would otherwise occur in their natural repertoire.

Environmental enrichment, although a relatively new research discipline is not a new concept. In fact, as early as 1925 Yerkes realised the necessity of improving captive animals' lives by suggesting that apparatus should be installed in captive primate enclosures for work and play.

The same concept persisted throughout the decades and Hediger in 1950 also noted similar problems in captivity.

"Clearly one of the most urgent problems in the biology of zoo gardens arises from the lack of occupation of captive animals."

His solution,

"...take the form of biological training and assumes the importance of occupational therapy" (Hediger 1950).

Although neither authors actually mention the word enrichment it is clear that the concept of what we call "enrichment" has been around for some time.

There are two main schools of thought regarding environmental enrichment. A behavioural engineering approach (Markowitz 1982), and the naturalistic approach (Hancocks 1980). The former approach encourages more activity and forage-related behaviours in animals kept in traditional barren conditions. Markowitz developed mechanical devices which deliver food on completion of a task. An example of this method can be seen in an enrichment device designed for captive pumas. The pumas

are able to trigger the release of an artificial prey animal which shoots across the cage. Capturing the prey results in the activation of the food dispenser. A study of this device showed an increase in activity in the puma and a reduction of adverse behaviours such as pacing and aggression (Synder 1977). This method follows operant conditioning techniques, such that the animal is required to carry out a task to obtain a reward. This method has been heavily criticised on the grounds that such behaviours stimulated by devices are no more natural than the behaviours they are replacing (Hutchings *et al.* 1978).

The second, more naturalistic approach, aims to recreate more natural settings by using substrates such as wood chippings, branches, plants etc. Foraging activities for example can then be encouraged by scattering food items onto the floor. This method aims to stimulate wild-type activity patterns by using similar stimuli to the wild (Hancocks 1980). However, this approach has also been criticised. Despite naturalistic enclosures being appealing to the eye, truly natural recreation is not always viable, due to factors such as lack of space and the destruction of natural materials by the inhabitants (Forthman Quick 1984). Forthman Quick (1984) suggested the two approaches need not be incompatible. To date many enrichment techniques utilise either method or a combination of the two.

In the wild many animals spend a large portion of their day engaged in feeding related behaviour: mountain gorillas spending up to 45% (Harcourt & Stewart 1984), bush babies *Galago senegalensis*, 30-50% (Bearder & Martin 1980) and giraffes *Giraffa camelopardalis* up to 74% (Pellew 1984a). For this reason many enrichments are aimed at providing food in a more challenging way such as 'flying meat balls' in the serval (Law *et*

al. 1990). A mechanical device shoots meat balls across the cage and the serval has to chase and catch the food item.

Most of the studies in environmental enrichment up to now have been concerned mainly with primates (Bloomsmith *et al.* 1988; Bryant *et al.* 1988; Chamove 1989a) using devices such as puzzle feeders (Cole 1987; Line *et al.* 1987), whereby the animal obtains food by using tools or by dexterous manipulation. Carnivores are also extremely popular where environmental enrichment is concerned, (Carlstead *et al.* 1991; Foster-Turley & Markowitz 1982; Law 1993; Mansard 1989). Some examples of carnivore enrichment include: Christmas trees for bears (Acuna 1993); cricket dispensers (Allen *et al.* 1989; Van Den Sande & Van De Bergh 1976) where the crickets are placed in hollow log containers partially filled with shredded newspapers and they escape through holes into the enclosure. Ice blocks (Law *et al.* 1986), which are food items frozen into ice blocks of varying size, are also used for many species of carnivores.

Although some work has been done on herbivores (Carlson & Schanberger 1988; Sharpe 1997), they still remain very much in the background regarding behavioural and enrichment studies in zoos. Some enrichments for herbivores include peanut feeders (often used for elephants) in the form of a jumbo sized boomer ball with small holes drilled into it, suspended on a chain and filled with peanuts (duBois 1991).

There are numerous aims and goals of environmental enrichment. Directly desirable outcomes include increasing stimulation and complexity of an environment, whilst reducing stressful stimuli. Enrichment aims to allow for the expression of species appropriate behaviour and allows for some element of control by the animal over their

environment. Enrichment has proved to be successful in obtaining these desirable effects. Gluck *et al.* (1973) were among the earliest researchers quantifying the effects of environmental variables on the behaviour of captive animals. Enrichment also aims to provide the animals with the necessary requirements for successful reproductive behaviour and parental care, and by providing a developmental environment required for the growth of normal behavioural and hence reproductively viable adults (Harlow and Harlow 1962; Carlsted & Sheperdson 1994).

Other effects of environmental enrichment include an increase in behavioural diversity and repertoire expressed (Pappas 1993; Shepherdson *et al.* 1993). Carlsted *et al.* (1993) showed lowered adrenocortical levels in species with enriched environments, which may be indicative of a reduction in stress. Enrichment has also been shown to reduce excess inactivity and stereotypic behaviour (Powell 1995).

However, most zoos are on a limited budget, therefore the enrichments most likely to be successful are those that are cheap, easy to design and build and require little effort to operate and maintain.

1.9 *Wild Type Behaviour*

Wild type behaviour is often used as a bench mark whereby the welfare of captive animals is assessed and hence, the occurrence of wild type behaviour indicates 'good' welfare.

Hediger as early as 1950 suggested -:

“the standard by which a zoo animal should be judged should be according to the life it leads in the wild”

(Hediger 1950)

Later on, with the rising interest in environmental enrichment, Chamove (1989) added yet another goal to environmental enrichment, which was to alter the behaviour so that it was in the “normal” range of the animals behaviour.

Although it is generally assumed wild is best, this can be debated (Veasey *et al.* 1996). Very often the welfare of the animals in the wild is compromised by factors such as hunger, parasitism, disease etc. Predation inevitably compromises the welfare of the prey animal. Thus, a useful definition of welfare excluding these natural factors, might require human intervention. Even so, it can be argued that through pollution, deforestation, poaching etc. the welfare of wild animals is not optimal (Veasey *et al.* 1996). Studies on captive primates show that wild type behaviours are not essential for welfare to be improved (Markowitz *et al.* 1978; Chamove 1989a).

Even if it is agreed that wild-type behaviour is an indication of good welfare it does not mean that if a behaviour is performed in higher frequency or is absent in the wild, the animal is necessarily suffering. Giraffes for example, graze at a high frequency in captivity and often this behaviour is lacking or extremely rare in their wild repertoire. In captivity there are no predators present and individuals have greater access to grassy paddocks, therefore the absence of this behaviour in the wild may be due to necessity rather than choice (Dalton 1987). Does this mean then, that the occurrence of this behaviour in captivity indicates a reduction in welfare? I see no viable reason to suggest that this is the case. Another example involves the large cats: Leyhausen (1979) suggests that the inability of cats to perform hunting behaviour in captivity compromises their

welfare, however, it has been shown that in the wild, cats will refrain from hunting if scavenging becomes an available option to them (Lindburg 1988), therefore the absence of hunting behaviour is neither unnatural nor necessarily indicative of poor welfare.

It is impractical if not virtually impossible to simulate some animals' "normal" (i.e. wild-type) behaviours in captivity. There are many differences between captive and wild environments: the zoo environment lacks complexity, is predictable and there are many restrictions in the ways animals are able to perform certain behaviours such as feeding and foraging, in a way they would be performed in the wild (Shepherdson 1998). Additionally, variables such as predators; prey; space and group structure etc. that are present in the wild are lacking in captivity. For example, wild giraffes spend a large proportion of their day browsing and moving from tree to tree. In many captive situations due to space restrictions and lack of natural vegetation, they can not do this, therefore, the ability to perform a major behavioural activity is being prevented. As well as feeding and locomotary restrictions, male giraffes spend their days in search of reproductively receptive females. In captivity however, the male often only has 1- 2 females to assess, reducing not only the frequency of occurrence but also choice. Consequently, these animals will have to perform behaviours that may not be seen in the "normal range" of behaviours, such as grazing in giraffes.

In other words, if an animal is prevented from performing a behaviour, in its absence, another activity may be created or performed to replace the lacking activity. Animals are highly adaptable may alter their behaviour in order to adapt to a particular environment, in this case captivity. Due to the difference in conditions, the needs and/or requirements of the animals may be different in different environments. This

may mean that often overemphasis is placed on the importance of zoo animals exhibiting a wild type behavioural repertoire in captivity.

1.10 *Animals' Needs*

The idea that animals possess a need to perform certain behaviours, is not a new concept. Although the notion of 'behavioural needs' is wide spread, there still remains much debate as to what its precise meaning actually is. Jensen and Toates (1993), described 'behavioural needs' as,

"..the need to perform a specific behaviour pattern whatever the environment is like and even if the physiological needs which the behaviour serves are fulfilled."

(Jensen & Toates 1993)

Baxter (1983) examined nest building in sows and found that when prevented from nesting, they will develop abnormal behaviours, such as stereotypies. This indicates that nesting may be an activity the animals have a need to perform. Once the concept of 'needs' is established the next stage is to ascertain which behaviours need to be performed.

Some argue that animals have a need to perform all the behaviour activities shown by their wild counterparts (Thorpe 1965). Thorpe (1967) later suggested that the animal suffers if it does not perform behavioural patterns that are exhibited most frequently in wild-type behaviour, hence using frequency of occurrence and not

motivation as a criterion for assessing the animals' needs. Dawkins (1980) argued that although captive animals might not necessarily exhibit behaviours as frequently as in the wild, this is not an indication that the animal is inevitably lacking in a need or is suffering. Furthermore, infrequent behaviours in the wild may nevertheless be vital and carry strong motivation such as bathing in the American mink *Mustela vison* (Cooper & Mason 2000).

There are two types of "needs" of an animal, Ultimate and Proximate (Dawkins 1983). Ultimate need suggests that without this commodity the animal will die or fail to reproduce. Proximate needs are needs which have high levels of causal factors (or are highly motivated), but the animals will not die in their absence. In the wild, ultimate and proximate needs are strongly related. An animal often satisfies its proximate needs in order to fulfil its ultimate needs. If an animal is not hungry it will still forage for food in order to prevent starvation later on. If however, the animal is starving it must forage to survive hence, a once proximate need has now become an ultimate need. In other words their relationship is so strong that often initial proximate needs can develop into ultimate needs, if the proximate need is not satisfied.

Conversely, in captivity the two types of needs are often decoupled, as the environment provides for the ultimate needs. Captive environments provide all the necessary physical attributes for the animal to survive, such as, food, shelter etc. By eliminating these needs the animal is left then to fulfil only proximate needs. These needs are motivated in a similar fashion to that in the wild except their priorities have changed. This leads to the concept that what may be a low priority behaviour in the wild, may become a high priority behaviour in captivity. This concept also disagrees with Thorpe's (1965; 1967), view that an animal suffers if it cannot perform the

behaviours most frequently exhibited in the wild. Hence, the needs of animals in captivity are different from the needs of their wild counterparts, despite their underlying motivations remaining the same. Hughes and Duncan (1988) state that the concept of behavioural needs can only be explained if it can be related to some model of motivation.

1.11 *Consumer Demand Theory*

Dawkins (1983) suggested the motivation or preference of an animal to exhibit a certain behaviour can be correlated to Laidlers' (1981) economic "consumer demand theory". This theory is based on a study of people with limited income faced with a choice of what to spend it on. If people were to have their income reduced and still continued to buy an item even at the cost of other items, the demand is said to be "inelastic". If, on the other hand, they stopped purchasing an item that they previously used to acquire then the demand is said to be "elastic". Elastic items are then said to be luxuries, inelastic items are said to be necessities (Laidler 1981). Relating this theory to biology, the constraint or limited resource can be considered time or energy, i.e. money is proportional to time or energy (Dawkins 1983). The amount of energy spent per unit time is analogous to work, therefore, the harder an animal has to work the more energy per unit time is being spent. Hence, the biological "price" is the how hard they will work to gain an item.

The more important a behaviour to the animal the harder they should work, i.e. the behaviour has a relatively inelastic demand. Behaviours that are not of great

importance to the animal should show an elastic demand, i.e. they should not work as hard for the ability to perform the behaviour. So, the key to studying behavioural preferences is the “price” the animal has to pay.

1.12 Preference Testing

Increasing an animal’s range of stimuli in captivity often improves their well-being by increasing the range of behaviours expressed and reducing the performance of abnormal behaviours (Odberg 1987). With this in mind, ways and procedures of identifying these important stimuli needed to be developed. Preference testing developed in the early 70’s when the controversy over animal welfare was high. Today there is still much controversy surrounding assessment of animal welfare. Preference tests are used to examine an animals’ preference for a particular environment or bedding (Hughes & Black 1973; Dawkins 1983; Hunter & Haupt 1989) and behavioural priorities (Bubier 1996; Cooper & Mason 2000). Preference tests are mostly used for lab and farmed animals or in captive test centres. To date there are no reports of preference testing being performed on zoo housed animals.

The overall aim in measuring preferences is to manipulate access “fees” and record the maximum “price” the subject is willing to pay in terms of work to reach a range of commodities (Matthews *et al* 1995). Fraser & Matthews (1997) summarised four main ways to measure the price paid.

The first one is to use *operant response* to vary price (Matthews & Ladewig 1994). This is similar to the Skinner box, the idea of having the animal press a lever at intervals to obtain a reward. The more frequently they press the lever, the more motivated the

animals are towards the reward. Secondly, cost can be manipulated by providing the animals with an *obstruction test* (Petherich & Rutter 1990)(Cooper & Appleby 1995). This requires the animals to overcome some form of obstacle, or make them work for their reward. *Aversion testing* (Rushen 1986), tests how much of a adverse stimulus the animal will go through to obtain their reward. This is usually done using electric shocks, bad tasting food etc. Finally, *limited time budgets* (Dawkins 1983), where the animals have to choose one behaviour or another in a limited amount of time.

When examining preferences, certain considerations must be examined. Firstly, animals, like people, may not always choose what is best for them in the long run (Duncan 1978)(Van Rooijen 1982). Also this economic method of measuring preferences provides only a way of ranking priorities that are more or less important to the animal, not a method of measuring how motivated an animal is to perform certain behaviours. Finally, the preference for one behaviour or commodity over another, does not necessarily indicate the animal is suffering if only the less preferred commodity is provided.

1.13 *Herbivores in Research*

As previously mentioned section 1.8, behavioural research on herbivores is often neglected in favour of other species. However, a small amount (in comparison to other species) of research has been conducted on captive herbivores. Various enrichment experiments have been conducted for example, the okapi *Giraffa okapi* (Alison 1994); stabled horses *Equus caballus* (Winskill *et al.*1996) and Przewalski's horses

Equus ferus (Henderson 1994) and studies on how herbivore behaviour is affected by enclosure size (Henderson 1994; Veasey *et al.* 1996), social grouping (King 1996) and mixed exhibits (Anderson 1992).

This study is concerned with two species of herbivore, the giraffes *Giraffa camelopardalis* and the Brazilian or Lowland tapir *Tapirus terrestris*. A review of both species wild life strategies and ecology is discussed in Chapter 3.

The most popular areas of research in captive giraffe include the examination of tongue playing behaviour and oral stereotypies (Koene & Visser 1996), social attachment (Tarou *et al.* 2000) and feeding ecology (Pellew 1984a). In the case of the Brazilian tapirs, there are very few previous studies. Most studies that have been conducted on Lowland tapirs are largely anatomical (Donat, 1981), physiological (Frolka 1989) and reproductive (Frerick 1982). However, a few behavioural studies have been conducted, these are enrichment (Sharpe 1997), activity budgets and use of exhibit space (Mahler 1984). Reference to previous studies of both species will be made in the relevant chapters.

1.14 Project Aims

An underlying title of this project should be "How should animals behave in captivity?" This may be somewhat misleading however, as this study does not provide any definite answer to this question posed. What this project does do, is to examine a number of theories and issues surrounding this question, with a view to providing a greater understanding of such a controversial and complex issue. This project examines

closely the behavioural properties i.e whether the behaviours are inelastic or elastic, of two species and aims to devise a method whereby the needs and priorities of captive species may be assessed. Ultimately, this projects aims to provide an in depth look at the behaviour of these two species, with a view to ascertaining the needs of these species in captivity and to address fundamental welfare and behavioural issues associated with zoo housed animals. I intend to achieve these aims by answering the following questions:

- (i) How do both species behave over a 24 hour period in captivity?
- (ii) Are their activity budgets similar to those of their wild counterparts?
- (iii) Can a wild type activity pattern be elicited in a captive environment?
- (iv) What are the behavioural properties of giraffes and tapirs and do they change with environment?
- (v) Can preference testing be conducted successfully in a zoo environment?
- (vi) Do the animals demonstrate preferences for different commodities?

Giraffes and Tapirs were chosen for this particular study for a number of reasons. Firstly, compared to other species such as carnivores and primates, herbivores are amongst the least studied group of animals, particularly with respect to captivity. This may be due to the lack of complex behaviours that are shown by primates or perhaps it is because they are not perceived with the same popularity and exoticness as

carnivores are by the public. Whatever the reason, herbivores are underrepresented in captive zoological literature. I believe that herbivores can be as behaviourally interesting as just as important as other groups of animals facing reductions in wild populations.

Herbivores spend a large portion of their wild budget feeding and foraging for food, in captivity they can rarely perform these behaviours to the same extent as in the wild. Carnivores on the other hand, such as large cats, often spend a large portion of their wild budget resting, a behaviour which can be performed in captivity to similar levels observed in the wild. Herbivores are therefore a group, which are most likely to behave the most differently in captivity compared to their wild counterparts. This is an interesting aspect particularly when trying to ascertain how animals should behave in captivity. Wild type behaviour is often referenced when dealing with captive studies and so, by using a group of animals which do behave so differently to the wild, it enables the difference between wild and captive behavioural patterns and reasons for these differences, to be examined.

Finally, giraffes and Brazilian tapirs were chosen specifically for this project, since neither species are endangered nor on a reintroduction program. If an animal is endangered or on a reintroduction program, various other considerations must come into play, as the primary aim may not only be concerned with the animals' welfare. This means that for the purpose of this study, research is concerned with behavioural and welfare issues only and therefore, does not bring the concerns of species survival into consideration, which would mean examining breeding, genetics etc. This concept will be discussed further in the discussion chapter, 11.

Chapter Two

STUDY LOCATIONS

2.1 *Dublin Zoo, Ireland*

The Zoological Society of Ireland was first established in 1830, opening to the public on September 1st 1831. This makes Dublin Zoo amongst one of the oldest zoos in the world. Dublin Zoo is situated in the Phoenix Park, north of the city. At the beginning it was located on *c.*15 hectares, then it developed into *c.* 70 hectares and continues to increase in size, with the latest development the African Plains. The African Plains will add a further *c.* 70 hectares to the ever expanding zoo and will house a wide range of large African ungulates in naturalistic enclosures.

When the zoo first opened it had a small collection of animals, 47 mammals, 72 birds and 4 reptiles, most of which were donated by London Zoo. Today it has a relatively large collection consisting of *~*646 specimens. In January 2001 Dublin zoo housed 279 mammals, 310 birds, 57 reptiles. Giraffes were first exhibited in Dublin Zoo during 1844. Tapirs however, did not arrive in the zoo until over a hundred years later, with the first tapir arriving in 1963. Both species have demonstrated successful captive breeding throughout the years.

2.2 *Fota Wildlife Park, Cork, Ireland*

Fota wildlife park is a relatively new institution. It was established by the Zoological Society of Ireland in 1982. It is situated on the Fota Estate Cobh, Co. Cork. The *c.150 hectares* on which it stands was donated to the Society by the University College Cork. In 1982, the first animals to arrive were zebras, then cheetahs and thirdly giraffes.

It was first opened to the public in 1983, at which time it housed 53 mammal specimens, (7 species), 6 species of primates and 19 species of birds. Today Fota is a hugely successful breeding center for giraffes and cheetah. It is currently one of the top breeding centers for cheetah in Europe.

2.3 *Chester Zoo, England*

Chester Zoo was originally established from a private collection. In 1934 Chester zoo became part of the North England Zoological Society. From a small private collection Chester Zoo continued to rapidly expand after World War II. In 1977 Chester zoo became the first institution in the United Kingdom to have an elephant born and reared successfully.

Currently Chester Zoo is one of the largest zoological gardens in the United Kingdom and houses over 5,000 animals in 170 hectares of garden.

Chapter Three

STUDY ANIMALS

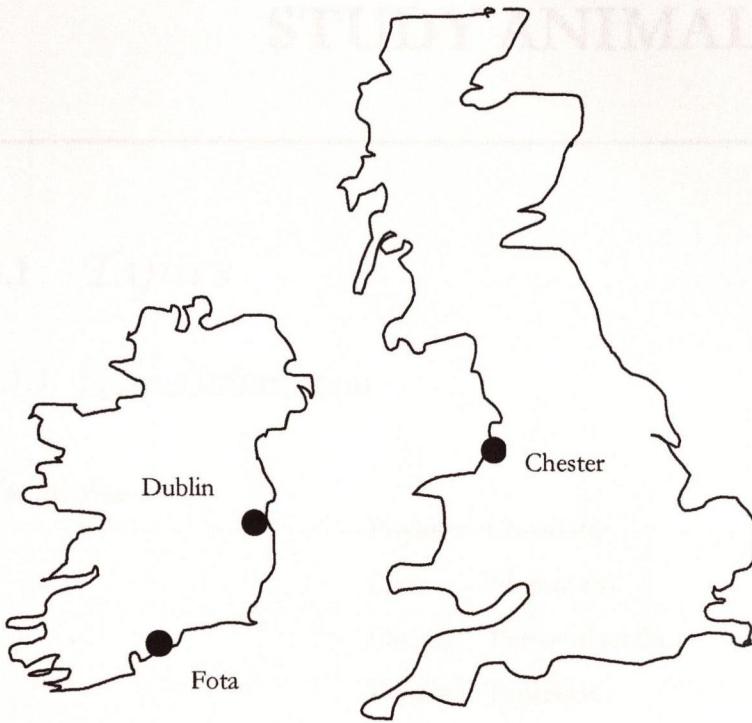


Fig 2.1: Map showing the locations of the zoos where this project was conducted

In depth discussions regarding the settings and management of the animals specific to each zoo will be discussed in the next chapter, chapter 3.

Chapter Three

STUDY ANIMALS

3.1 *Tapirs*

3.1.1 Species Information

Classification

Phylum: Chordata
Class: Mammalia
Order: Perissodactyla
Family: Tapiridae
Genus: *Tapirus*
Species: *Tapirus terrestris*

Perissodactyls

Tapirs belong to the order perissodactyla or the odd-toed ungulates. Perissodactyls contain 16 species in 6 genera and 3 families - the Equidae; Tapiridae and the Rhinocerotidae (Nowak & Paradisio 1983). Perissodactyls have fewer species than the artiodactyls or even-toed ungulates. However, during the early Tertiary (54-25 million years ago) they were the dominant ungulate order. Their subsequent decline is

more likely to have been as a result of climatic factors than direct competition with the artiodactyls (MacKinnon 1984).

Tapirs are closely related to the rhinos, with the rhinos representing an offshoot of the tapir family in the late Eocene (54 million years ago). These two families are quite often grouped together as the suborder Ceratomorphora (Janis 1984).

There are four species of tapirs, Mountain tapir *Tapirus pinchaque*; Baird's tapir *Tapirus bairdi*; Malayan tapir *Tapirus indicus* and the lowland tapir *Tapirus terrestris* with which this study is concerned.

Status

The lowland tapir (also known as the Brazilian tapir or south American tapir) has been categorised as "lower risk near threatened" (1996 IUCN Red List of Threatened Animals). The increasing pressure from humans has made this species vulnerable to extinction, and is presently listed in CITES Appendix 1.

Tapirs are among the most primitive large mammals of the world, in so far as they have changed little throughout their evolution (Lekagul & McNeely 1977; MacKinnon 1984). They are also regarded as behaviourally primitive, in that their social structure and social communication is less complex than other ungulates (Janis 1984).

Physical Characteristics

Tapirs have a stout body, slightly higher at the rump than the shoulders, with short but sturdy limbs. The neck of tapirs is short and the head extends into a short,

fleshy trunk derived from the nose and upper lip, with the nostrils at the tip. This small proboscis is extremely sensitive and is used to gather food into the mouth (*pers. observation*).

The ears protrude and are often tipped with white. They have good hearing although not as acute as their sense of smell (MacKinnon 1984). Vision is less important for these animals since they are mainly nocturnal, and so their eyes are small and lie deep in the sockets. Tapirs have retained the complete mammalian dental formula, and have a generalized skull shape.

Lowland tapirs have short bristly manes extending along the back of the neck, which probably serves to protect their most vulnerable part of their body from the bites of their main predator, the jaguar *Panthera onca* (MacKinnon 1984). Tapir skin is tough and is covered with sparse hairs. Their coat is a dark brown to a reddish. Newborns have dappled white spots and stripes, this acts as a camouflage in the jungle undergrowth (Barongi 1986).

Tapirs have four toes on their forefeet and three on the hind feet. The fourth toe which is slightly smaller than the others, is located to one side and is slightly higher up. This fourth toe is only functional on soft ground. All toes are hoofed and are padded underneath.

Habitat

Brazilian tapirs are the largest terrestrial mammals native to Amazonia. Commonly they inhabit lowland South American forests and are distributed from Columbia and Venezuela south to Paraguay and Brazil. However, in certain parts of

South Eastern Brazil, tapirs are occasionally found at altitudes exceeding 1700 metres (Grimwood 1968). The most important habitat for these species are moist seasonally inundated areas which are wooded or grassy (Bodmer & Brooks 1997).

Feeding

The compact streamlined bodies of the tapirs enable them to sift through the dense undergrowth of the forest to forage. Tapirs are both browsers and grazers, feeding on grasses, aquatic vegetation, leaves, buds, soft twigs and fruits of low growing shrubs (Burton 1956; Crandall 1964). Like all perissodactyls they are hindgut fermenters (Janis 1976). More than 60% of the Brazilian tapirs diet comprises leaf and other plant material (Bodmer 1986). They follow a zigzag course when feeding, moving continuously and taking only a few leaves from any one plant (MacKinnon 1984). Their proboscis is used to locate and manipulate food by pulling leaves and shoots within reach of the mouth, with the incisors clipping vegetation (D'Aulaire & D'Aulaire 1979).

Social Structure

Apart from mothers with young, tapirs are usually solitary animals and range over wide areas (Bodmer 1986). They are territorial and mark their territory with urine (Klingel 1977).

Predators

Tapirs walk with their noses close to the ground, probably to recognise their whereabouts and to detect the scent of other tapirs and predators (D'Aulaire & D'Aulaire 1979). They often follow the same routes and may wear tracks to standing water (Eisenberg 1989). The main predators of the tapirs are the jaguars *Panthera onca*. As well as retreating to the water when alarmed, tapirs may crash off into the bush or defend themselves by biting.

Other

Tapirs are excellent swimmers (Eisenberg *et al* 1990), and spend a lot of time in water feeding, cooling off, or ridding themselves of skin parasites. If alarmed they may also seek refuge in water and have the ability to stay submerged for several minutes. When tapirs bathe there is increased activity of their digestive tract and like hippos, they often defecate in the water. Besides being good swimmers tapirs are also agile climbers (Herskowitz 1954), scrambling up riverbanks and steep mountainsides.

Breeding

Tapirs are polyestrous and are capable of breeding throughout the year. Females are usually sexually receptive every two months or so. Mating is preceded by a noisy courtship consisting of high pitched squeals. Males and females stand head to tail sniffing their partners' genital area and moving around in a circle at increasing speed.

They nip each other's feet, ears and flank and prod their mates' belly with their trunk (D'Aulaire & D'Aulaire 1979; Eisenberg *et al* 1990).

Prior to birth, pregnant females seek a secure lair where they will give birth to a single offspring (twins are very rare). A female is capable of producing an offspring every 18 months. The youngster will stay with their mother until they are well grown. At about 6-8 months they will begin to roam independently, but are not sexually mature for another 2-3 years (MacKinnon 1984).

Gestation is about 390-400 days. In the wild tapirs are thought to have a longevity of up to approximately 30 years.

3.2.1 Dublin Zoo Group

Enclosure

The tapirs were moved to their current enclosure on the 10th June 1998. This new enclosure comprises of an outside grassy enclosure (1174 sq m) and a smaller inside enclosure (62 sq m). There is very little dense vegetation present and the entire outside enclosure is based on a hill. They are housed with *Maras Dolichotis pantagonum* however, no interaction between the two species has ever been recorded. Each area, both outside and inside contains a small pool with one point of entry and exit.

The outside enclosure's substrate is grassy and muddy and the inside enclosure contains bark chippings and straw bedding. The inside enclosure is heated at night all year round and both day and night in the winter.

Husbandry

The tapirs are fed one main meal in 24hrs. This meal is provided to them in a shared trough in their inside enclosure during winter and occasionally outside in warm weather, at about 10.00 hours. The main meal may also be supplemented throughout the day by *ad lib* browse and fruit. Their diet consists of fibre and protein supplements, with a mixed variety of fruit and vegetables. The Tapirs have 24 hour access to their outside enclosure all year round.

Individuals

Dublin Zoo currently houses two individuals of *Tapirus terrestris*, one male and one female. Both individuals are 16 years of age. Both were captive born and parent reared. As a breeding pair the two have had great success, producing 10 healthy babies throughout their 15 years at Dublin.

3.1.3 Fota Wildlife Park Group

Enclosure

The tapirs are housed in a grassy paddock (980 sq m) with a smaller inside (41 sq m) enclosure.

The outside enclosure is flat grassy terrain and the inside enclosure is a hut with straw substrate. They are housed with dwarf goats with some interaction between the two

species occurring. The tapirs do not have a pool in their enclosure. They have heaters in their inside enclosure.

Husbandry

The tapirs are fed twice daily in a trough which they share with the goats. They are fed in the morning at about 09.00 -10.00 hours and again in the afternoon at around 15.00 - 16.00 hours. Their main meals comprise mixed fruit and vegetables, and fibre and protein supplements, which may be supplemented with *ad lib* browse when available. Similar to Dublin the tapirs at Fota have 24-hour access to their outside enclosure.

Individuals

Fota currently houses a breeding pair of Brazilian tapirs. The male is 14 years old and the female is 13 years old. Similar to the Dublin pair, they were also captive bred and parent reared. This pair have also enjoyed a successful breeding rate producing 8 healthy offspring. However, unfortunately during the course of this study the Fota individuals sadly lost a new born to a twisted gut, just days after being born.

3.2.1 Chester Zoo Group

Enclosure

Chester's tapir enclosure comprises a large outside paddock (85.3 sq m), a hardstand area (3.9 sq m) and an inside enclosure (36.3 sq m). The outside enclosure is a mixture of hilly and flat grassy terrain a number of large trees and a small pool are

also present. Their inside enclosure contains straw bedding and areas of concrete. The tapirs have heaters in their inside enclosure which are used both diurnally and nocturnally.

They are housed with two capybaras *Hydrochoerus sp.*, with very little interaction occurring between the two species.

Husbandry

The tapirs are fed twice daily, once in the morning and once in the afternoon. Their morning feed is given to them in a heap in their inside enclosure and their afternoon feed is given to them in the hardstand area. They are fed a similar diet to those in the zoos described above.

Unlike Dublin and Fota, the tapirs at Chester do not have 24-hour access to their outside enclosure or indeed to the hardstand area. In the winter, during which this study was conducted, the tapirs were locked into their inside enclosure in the afternoon. On very cold days, the tapirs were only allowed access to their hardstand and not to their entire outside paddock.

Individuals

As with most zoos Chester also had a breeding pair. Both were 11 years of age and like the other two zoos have a successful breeding history. As with most lowland tapirs in zoos today, this pair were also captive born and parent reared.

3.2 Giraffe

3.2.1 Species Information

Classification

Phylum: Chordata

Class: Mammalia

Order: Artiodactyl

Family: Giraffidae

Genus: *Giraffa*

Species: *Giraffa camelopardalis*

There are about 9 subspecies of giraffe and they are classified according to their coat and the number of horns (Dagg & Foster 1976). Each giraffe has its own unique pattern of coat markings which is similar to that of the human fingerprint. The pattern remains the same from birth to death though the colour may change. The coat of the giraffe is typically orange-brown separated by a network of cream buff lines.

Artiodactyls

Giraffes belong to the order Artiodactyla or the even-toed ungulates. The order Artiodactyl comprises of 187 species, 76 genera and 9 families - the Suidae; Tayassuidae; Hippopotamidae; Camelidae; Tragulidae; Moschidae; Cervidae; Giraffidae and Bovidae. The artiodactyla contain the most diverse array of large, land-dwelling mammals which

inhabit all habitats from rain forests to deserts and are found on all continents except Australasia and Antarctica. Artiodactyls first appeared in the early Eocene some 54 million years ago (Janis & Jarman 1984).

The order Artiodactyla comprises two different types of animals, the suoids and the ruminants. The suoids include pigs and their relatives, which are primarily omnivorous retaining low crowned cheek teeth and large tusk-like canines. The ruminants are specialised herbivores that have evolved a multi-chambered stomach and have adopted the habit of chewing the cud in order to digest fibrous herbage. They have teeth with ridges rather than cusps which the suoids have (Janis & Jarman 1984). The family Giraffidae belongs to the ruminant group and comprises two genera, the giraffes and the okapi. It is the giraffes with which this project is concerned with.

Status

Giraffes are not endangered presently, however there is evidence of local decline in certain areas (Pratt & Anderson 1982).

Physical characteristics

Giraffes are often perceived as anatomically curious with their short body in relation to the pronounced length of the neck. This foreshortening is exaggerated by the height of the legs with the forelegs being longer than the hind, so that the profile appears to be sloping continuously from its horn to its tail. The neck of the giraffe contains the usual seven vertebrae of most mammals, however, each one is greatly

elongated. The thoracic vertebrae have large forward facing dorsal spines which form the conspicuous shoulder hump, and serve as anchors for the attachment of the large muscles that support the neck and head (Lee 1993b).

A unique feature of giraffes is the progressive laying down of bone material around the skull. These bony growths are typically situated above each eye socket, centrally in the forehead and occasionally at the back of the skull. Typically an adult male skull can weigh up to three times as much as a female's which has fewer bony growths. Giraffes are one of the few ruminants to possess horns. Both sexes have horns which are covered with skin and have terminal tufts of black hairs. The horns of the males are usually thicker and heavier than the females, often fusing at their base and losing the terminal hair tuft (Pellew 1984b).

Another peculiar feature of the giraffes are their canine teeth which are splayed out into two or three lobes and possess molars covered with thick enamel (Walker 1968). They also possess a long black tongue which can be extended up to 18 inches (Pellew 1984b).

Giraffes very rarely lower their heads and tend to do so only whilst sleeping or drinking. An anatomical feature which compensates for the sudden increase in blood pressure when the head is lowered is the elastic blood vessels and valves in the venous system of the neck .

The best developed sense of the giraffe is its vision, despite their hearing and smell being highly acute also. The long range vision enables them to communicate with groups which are several miles apart which assists in herd cohesion and serves as an antipredator warning.

Habitat

Giraffes are distributed in Africa with the south of the Sahara being the area in which they are most abundant (Nowak & Paradiso 1983). They live in the open woodlands and wooded grasslands (Dagg 1971). They are most typically associated with acacia *Acacia*, myrrh *Commiphora* and open myrobalan *Terminalia* (Pratt & Anderson 1982). There is some evidence of sex difference in local habitat selection, with the female preferring the more open areas (Foster 1966).

Feeding

Giraffes are exclusively browsers. The bulk of their diet comprises leaves and shoots of trees and shrubs, which are supplemented by climbers, vines and some herbs. Flowers, seed pods and fruit are also eaten when in season. How food is gathered depends on the plants defences. Giraffes are extremely well equipped to deal with their favourite tress, acacia which possess thorns. With acacias, individual leaf whorls and shoot tips are bitten off, using the long tongue and sensitive lips to gather food into their mouth. The roof of their mouth is heavily grooved and this together with the copious amounts of viscous saliva enables the giraffes to compress and swallow the thorny food (Pellew 1984a). With thornless food giraffes using their splayed lobed canine teeth comb the leaves off branches. Feeding usually occurs at dawn and dusk with the main bouts of rumination occurring during the hot midday sun (Dagg & Foster 1976).

Giraffes can often be sexed from a distance by watching them feed, males usually feed fully stretched while the females tend to bend over the vegetation (Pellew 1984a). Females tend to feed more than males since males spend more time engaging in other activities such as maintaining dominance hierarchy and searching for reproductively receptive females (Pellew 1984b).

Over browsing is prevented by the presence of ants on food plants which seem to deter feeding giraffes (Moss 1989).

Social Structure

Giraffes form scattered herds, the composition of which are continuously changing (Leuthold 1979). Individuals band into loose groups for protection against predators. The home ranges of giraffes are large, up to about 120 sq kilometres for adult females, larger for young males and smaller for adult bulls (Pellew 1984a). Bulls are non-territorial and amicably coexist together within overlapping home ranges. This harmony is enabled due to the dominance hierarchy existing between bulls. Each individual knows their relative position and so aggression is minimised (Coe 1967).

Dominance hierarchy is established through rituals called 'necking' where the two individuals intertwine their necks. Occasionally the intensity of the encounter may increase and the two will use their horns to exchange blows to each others flanks (Innis 1958). Females also have dominance hierarchies albeit more subtle, with subordinate females usually being displaced at attractive feeding sites.

Predators

Giraffes do have a number of predators. Lions *Panthera leo* are amongst the main predators however, newborns up to about 3 months are often predated upon by hyenas *Hyaenidae*, leopards *Panthera pardus* and African wild dogs *Lycaon pictus* (Foster 1977). Some 50% of newborns are killed within their first 6 months of life (Pellevé 1984b).

Other

Giraffes can survive for long periods without water. They obtain up to 74% of their water requirement from the twigs of *acacia* (Foster 1977). However, they do make regular visits to water holes. When drinking giraffes splay their legs and bend down to the water source, this is one of the few times giraffes do not keep their head upright. At all other times the neck is held vertical except for short periods of sleep where the head is rested on the rump. Giraffes spend no more than 5 minutes sleeping at a given time (Pellevé 1984b). However, nocturnal activity is largely dependant on the amount of moonlight available (Leuthold 1979).

Locomotion in giraffes is also a peculiar characteristic, in that when walking the two legs on the same side of the body are swung almost at the same time. When galloping both hind legs are brought forward together and placed outside the front. Giraffes are capable of galloping at speeds of up to 65 kilometres per hour (Innis 1958). Young giraffes can out run adult giraffes due to their low inertia (Pratt & Anderson 1982).

Breeding

3.2.2 Dublin Zoo Giraffe

Due to the ability of giraffes to exploit a high quality diet, breeding occurs throughout the year. Males wander from group to group in search of reproductively receptive females. They do this by tasting the urine of the female by flehmen or 'lip-curl response'. This often leaves the bulls living quite solitary lifestyles. If the female is in heat the male will displace the subordinate males and reproduce (Coe 1967).

Females giraffes are sexually mature at about 5/6 years (Kloppel 1982) and have a mean interval between births of about 20 months (Pellew 1984b). The gestation period in giraffes is 15 months. Females can have up to 12 offspring in a lifetime, however, the usual is about 6-7 young. Males become sexually mature later than the females. Twins are very rare in giraffes and normally they produce 1 offspring at a time (Moss 1989). They are able to mate from about 8 years. The older the male gets, the less chance he has of mating (Pellew 1984b).

Calves are born in isolation. Calves are born in traditional calving grounds and this facilitates the formation of calf groups which a newborn will join at about 1-2 weeks old. Females tend to return to the same calving grounds for each birth. Female giraffes are renowned for being excellent mothers and will often vigorously defend their calves from predators. Male calves are usually weaned at about 15 months and females a couple of months later. Juvenile females will remain with their mothers in their home range but males post weaning will form all male group and disperse from their natal area at about 3 to 4 years. Giraffes have a lifespan of about 25 years in the wild (Walker 1968).

3.2.2 Dublin Zoo Group

Enclosure

The giraffe enclosure is a very old enclosure, is small and relatively bare with no natural vegetation apart from a tree surrounded by mesh around the trunk, in the centre and grass about the edges of the outside paddock. The giraffes have two areas in their outside enclosure (677 sq m) and an inside enclosure. The inside enclosure is hardstand with straw bedding. The male is housed in a separate stall next to the two females (male: 62 sq m; females: 91 sq m). Each stall comprises a hay rack and a water trough. The outside enclosure consists of a hardstand area and a muddy grassy paddock with a dead tree in the centre. They are housed next to the elephant enclosure. The outside enclosure contains browse poles, hay stack and a drinking water trough.

During the summer 2000, the giraffes were moved to a new more naturalistic enclosure, as part of a new phase the African Plains. This enclosure is a large grassy field (21,981 sq m) where they are housed in a mixed exhibit with zebra *Equus burchelli*, oryx *Oryx leucoryx* and ostrich. As well as this new mixed exhibit, the giraffes were introduced to three new giraffe members. These new individuals were not examined for the course of this project.

Husbandry

The giraffes are housed very much in according to the weather. In extreme winter the giraffes are housed indoors throughout the day. During wet and windy weather they are housed outside in their hardstand area only, with no access to the padlock or to their inside quarters. During the summer and in good dry weather the giraffes are locked into the outside grassy padlock. If they are being housed outside, they are let out from about 9-10am and returned to their indoor quarters from about 4-5pm.

Giraffes are feed in the early evening in their inside quarters where they are feed a mixture of fibre and protein supplements with a mixture of fruit and vegetables. The two females share a trough while the male has sole access to his. In addition to this, giraffes are given *ad lib* browse first thing in the morning, and *ad lib* fruit during periods of public feeding.

Individuals

Dublin Zoo currently houses three giraffe individuals. One male and two females.

The male giraffe belongs to the subspecies *Giraffa camelopardalis rothschildi* or the rothschild giraffe. The two females are not members of a subspecies they are hybrids between to subspecies. Segregating giraffes into subspecies is often an ambiguous task. In captivity subspecies are often housed together, due to lack of space or lack of knowledge in defining the subspecies. For this reason, often a lot of breeding goes on between subspecies in captivity resulting in hybrids between subspecies. This is what has occurred with the two female giraffes at Dublin Zoo.

	Male	Female 1	Female 2
Date of Birth	26/02/88	22/07/77	27/11/92
Age	13 yrs	23yrs	9yrs
Birth type	Captive born	Captive born	Captive born
Rearing	Parent reared	Parent reared	Unknown
Birth location	Fota, Co. Cork	Dublin Zoo	London Regents Park
No. of offspring	3 males; 1 female	5 males (1 dead as newborn); 3 females	0

Table 3.1: Table showing individual information on each giraffe being studied

Chapter Four

METHOD

4.1 Preliminary Study

This project commenced in October 1998 with initial observations carried out on both species at Dublin Zoo. Each animal was observed in their present enclosure at various random intervals. Approximately 1- 2 weeks was spent observing the animals, recording and noting the variety of behaviours performed in each of the species repertoires. These preliminary observations enabled an ethogram to be constructed. An ethogram is a descriptive list of categories of behaviours being observed (See Appendix 2a & 2b for Ethograms).

Once an ethogram had been constructed for each species, checksheets were then made. A checksheet is a grid containing time intervals and the categories of behaviour in which all observations were recorded. A checksheet standardises observations so that they are easily conducted and analysed (Kleinman 1974) (See Appendix 2a & b for an example of checksheets used for this study).

Preliminary studies also enabled various sampling methods to be tried and tested. This made it possible to attain the best method by which accurate data could be acquired from these species.

4.2 *Data Collection*

Data for both species were collected using an instantaneous scan sampling technique, with 30 sec inter-sample intervals (Martin & Bateson 1986). Behaviours which were short in duration and would have therefore been underestimated by instantaneous scan sampling, were recorded at each occurrence. In other words, states i.e. activities occurring over a period of time, usually behaviours lasting over 15 seconds, were recorded every 30 seconds and each occurrence of events i.e. behaviours that are less than 15 seconds duration, were recorded (Altmann 1974).

Hourly records provided the baselines with which experiments were compared. Daily and 24 hour records provided an overall picture of the individuals' activity budget in captivity. All data for each observational hour were replicated 5 times to allow for accurate statistical analysis.

Individual methods for each aspect of the project will be discussed in depth in each appropriate section.

4.3 *Statistical Analysis*

All Statistical analyses were carried out on SPSS version 6. Non parametric tests were used since plotted data indicated non normal data distribution. Comparisons between two samples eg. Male and female, winter and summer, were carried out using a non-parametric

Mann-Whitney U-test for unmatched samples. This test uses the mean ranks of the observations and demonstrates differences in medians.

For comparisons between three or more samples eg. three individuals, a non-parametric Kruskal-Wallis test for unmatched samples was used, followed by a post hoc analysis. Similar to the Mann-Whitney U test, this test uses the mean ranks of the observations and demonstrates differences in medians. All graphs were constructed using SPSS and Microsoft Excel packages.

More specific analysis and methodology will be described in each appropriate chapter.

4.3 *Sample Sizes*

A problem often arises regarding sample sizes and statistics when dealing with zoo research. It is a common problem which is continuously discussed and debated at various zoo related meetings. When researching in zoos, the sample size is often small, it can be as little as 2 individuals. This presents a dilemma with statistical analysis, as most tests require a sample size of 5 or more. In order to get over this problem, it is generally accepted in zoo research to claim independent samples within one sample (Wechesler 1991; Acuna 1993; Barongi 1986). For example, if one is examining the behaviour of a single individual under normal circumstances this would indeed be an independent sample and hence a sample size of one, however, due to the nature of zoo research each replicate taken on this individual may be regarded as an independent sample and hence, the sample size would be the number of replicates. Although not ideal, it is a general consensus in zoo research and is currently utilised as such, until a

more suitable method of analysis becomes available. As I encountered this problem with groups of animals consisting of only 2 or 3 individuals, I counted each replicate as individual samples, hence my sample size was 5 for each individual.

Activity Budgets

Chapter Five

ACTIVITY BUDGETS: TABLES

5.1 Introduction

Activity Budgets

Chapter Five

ACTIVITY BUDGETS: TAPIRS

5.1 Introduction

Studies of captive animals usually occur within the opening hours of the zoological institution. This often means that detailed reflections of the animals' behaviour are not obtained and hence, only a broad representation of their behaviour can be obtained from these specific limited observation periods. Furthermore, nocturnal behaviour is seldom, if ever examined. It is for these reasons, that a full 24 hour activity budget was looked at in the tapirs.

Tapirs are extremely elusive animals and very little is known about their behaviour and lifestyle in the wild, particularly the lowland tapir (Medici *pers.com*). The lowland or Brazilian tapir *Tapirus terrestris*, although still threatened, is probably the least threatened of the species and the least studied (Lee 1993a). However, exact wild population numbers are unknown for any of the species.

This section of the thesis examines 24 hour activity budgets for captive tapirs, the difference between individuals across seasons and compares the difference between two different groups. Finally the difference between wild and captive behaviour is looked at briefly for this species.

5.2 *Method*

Daytime activity budgets for the tapirs were recorded for two zoos, Dublin zoo and Fota Wildlife Park. The tapirs were observed and data recorded onto checksheets directly for 50 minutes of each hour of observation (see Appendix 1a). 50 minutes of each hour was chosen as a representative for each hour of observation. Data were recorded using instantaneous 30-second group scan sampling (Altmann 1974). Group sampling was made possible since each group comprised of two individuals only.

The checklist comprised 8 main behavioural categories -: resting; feeding; standing; locomotion; exploratory; sexual; aggressive and "other" (see Appendix 2a for an ethogram of behaviours). Each behavioural category was recorded as a state, and the percentage of the time spent in that activity in the hour of observation was recorded. All instances of interactions between the two individuals were collected for the 24 hour activity budgets in the Dublin individuals only. The area of the enclosure occupied by each individual i.e. inside or outside and the proximity of the animals to one another were also recorded for all individuals. Proximity was defined as < 1 metre, which was estimated by the observer. Each hour of observation was replicated 5 times, over 1 week for each group in each season except for the 24 hour data (see below).

A 24 hour activity budget was recorded for the tapirs at Dublin zoo only. The 24 hour period was divided into two sessions, diurnally 08.00 - 18.00 hours and nocturnally 18.00 - 08.00 hours. Diurnal data were collected in one session on random days over three weeks for the winter season i.e. September – March, and over 1 week in the summer season i.e. April - August. Nocturnal data were collected 1-2 nights per

week over 3 weeks in the winter season only. Due to the large inactivity levels of the tapirs at night, and since initial studies showed little variation due to seasons, nocturnal data was not collected during the summer. For the winter results at Dublin, the group comprised a juvenile which was 3 months old at the time of data collection. Summer results for Dublin were collected after the juvenile had been translocated to another zoo, and the female was pregnant again.

Activity budgets for Fota individuals were collected in the same fashion as the Dublin individuals. No nocturnal data were collected in Fota, only diurnal. The hours of recordings for the Fota group were between 10.00-17.00 hours, both in winter and summer. This observation period was chosen as these were the hours of opening for the park in the winter and data collection was only allowed within the park's opening hours. Although the summer opening hours were slightly extended, the observation times remained the same so a direct comparison could be made. A juvenile was not present in either season of data collection for the Fota individuals, however, in the winter season the female was pregnant. At the time of summer collection the female had had a juvenile two months earlier, but sadly this baby died due to a twisted gut when he was only a few days old. It was unknown whether the female was pregnant at this time.

When comparing zoos, the hours between 10.00-17.00 were extracted from the Dublin data so it could be directly compared to the Fota data. Data was also separated into morning data, 10.00-13.00 hours and afternoon data, 13.00-17.00 hours, so that any differences occurring between the zoos could be examined more closely.

Chapter 4, section 4.3 describes the statistical tests that were used to analyse the results.

5.3 Results

5.3.1 24-hour Activity Budget

Behavioural Categories

Graphs (Fig. 5.1a and 5.1b) show the proportion of the time the male and female spent in each behavioural activity recorded, for each hour of observation over a 24-hour period as recorded over the winter season.

The graphs show that both individuals were at their most active early in the morning and mid-afternoon. The male showed very little activity between 6pm and 4am. The female also showed this but did show a small increase of activity late in the evening between 20.00 and 22.00 hours. Both individuals demonstrated a behavioural pattern of long periods of rest followed by brief periods of feeding and other activities. When examining their overall behaviour throughout the 24 hour period it can be seen (Fig. 5.2) that both individuals exhibited resting behaviour at a significantly higher percentage than any of the other behaviours in their repertoire (male: $72\% \pm 2\%SE$; female: $68\% \pm 2\%SE$). Their second most frequent behaviour performed was feeding (male: $11\% \pm 1\%SE$; female: $15\% \pm 1\%SE$).

Statistical analysis using a Mann Whitney U test showed that over a 24-hour period no significant difference occurred between the individuals in the amount of time they spent in each activity except sexual activity ($U=6586$; $N=5,5$; $P= 0.05$), with the male performing this behaviour for longer in the budget than the female. Sexual activity

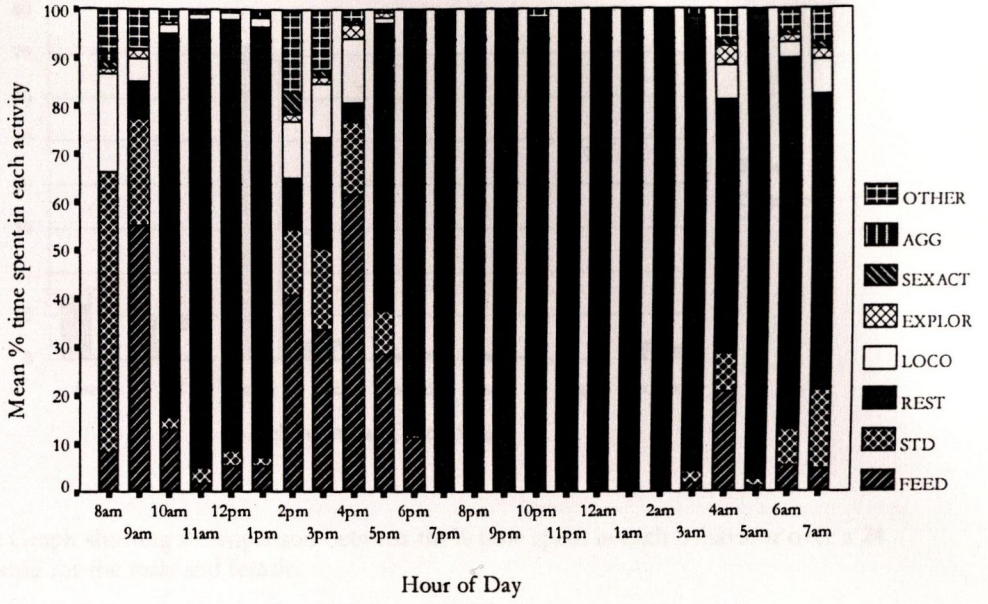


Fig. 5.1a. : Graph showing the hourly activity budget for the male over 24 hours during the winter season

AGG= Aggression; SEX ACT= Sexual Activity; EXPLOR=Exploratory
 LOCO= Locomotion; STD= Stand

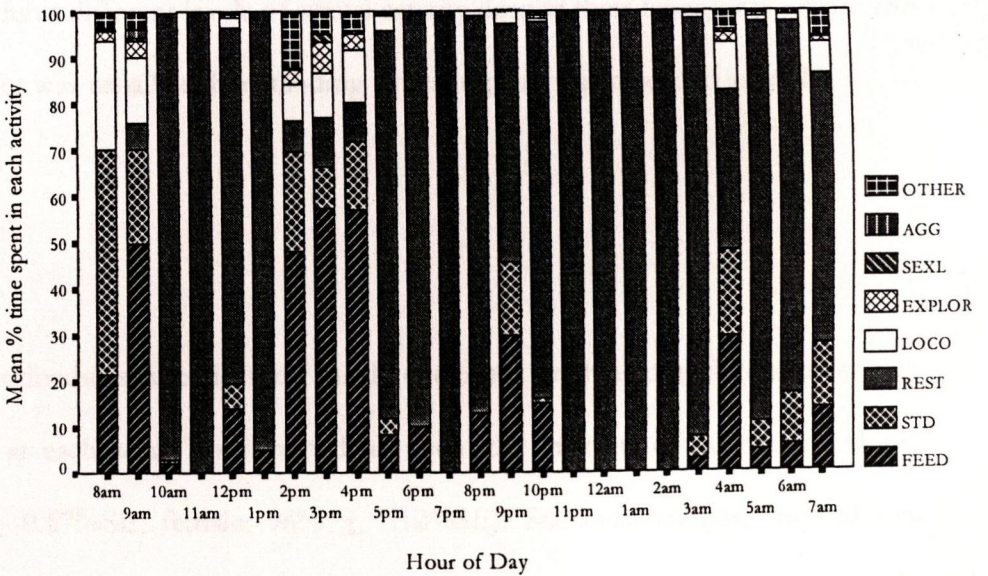


Fig 5.1b: Graph showing the hourly activity budget for the female over 24 hours during the winter season.

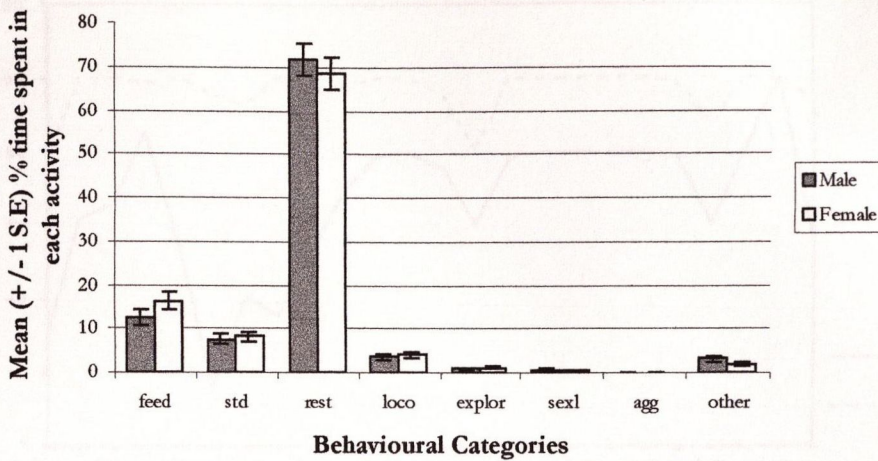


Fig 5.2: Graph showing a comparison between the % time spent in each behaviour over a 24 hour period for the male and female.

was scored only for the active participant and not the passive recipients, hence one individual can have different levels of sexual activity despite their being only a pair. The passive recipient was usually either standing or resting and was recorded as such.

Area Usage

Whether the individuals were in their inside enclosure or their outside enclosure was also recorded at each scan. Both individuals spent the majority of their time indoors (male: $98\% \pm 0.57\%SE$; female: $96\% \pm 1.12\%SE$). Statistical analysis showed that comparing the amount of time both individuals spent indoors was not significantly different over 24-hours.

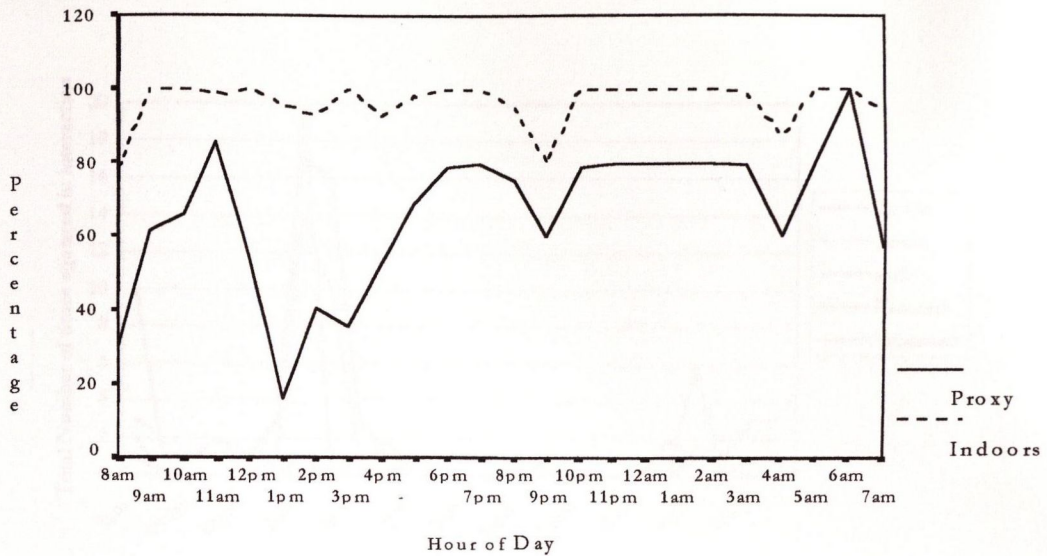


Fig 5.3: Graph showing a comparison between the mean percentage time the male and female spent in proximity and the amount of time they spent indoors over a 24 period

Proximity

Figure 5.3 shows the proximity of the tapirs to each other over a 24 hour period. At each 30 second scan, the proximity of the individuals to one another was also recorded, when there was less than 1 metre distance between the two. Measurements of this were estimated through observation.

The graph shows that they spent the longest together at 06.00 hours and the least amount of time together at 13.00 hours. Furthermore it can be seen that the amount of time spent indoors coincides with the amount of time spent in proximity, such that high peaks of proximity occurs when the individuals spent time indoors and low peaks of proximity occurred when the individuals were outdoors.

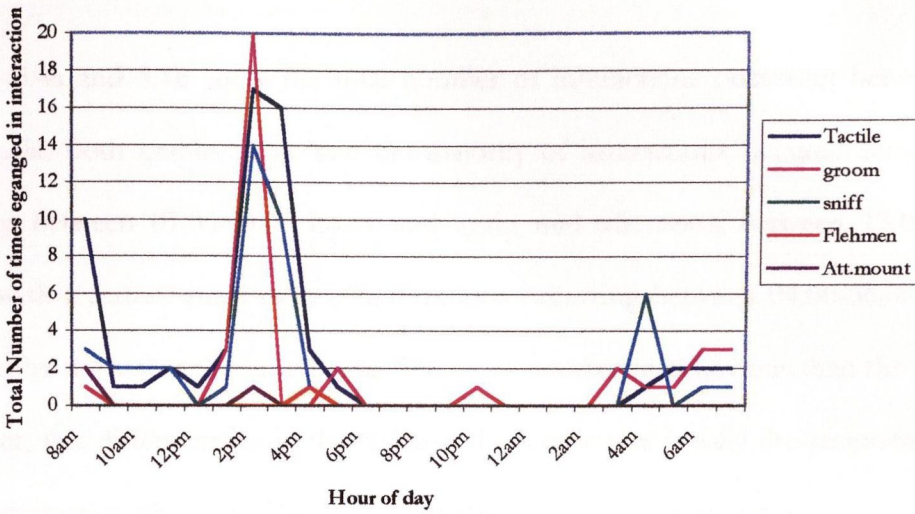


Fig 5.4a: Graph showing the total number of interactions advanced by the male toward the female over a 24 hour period

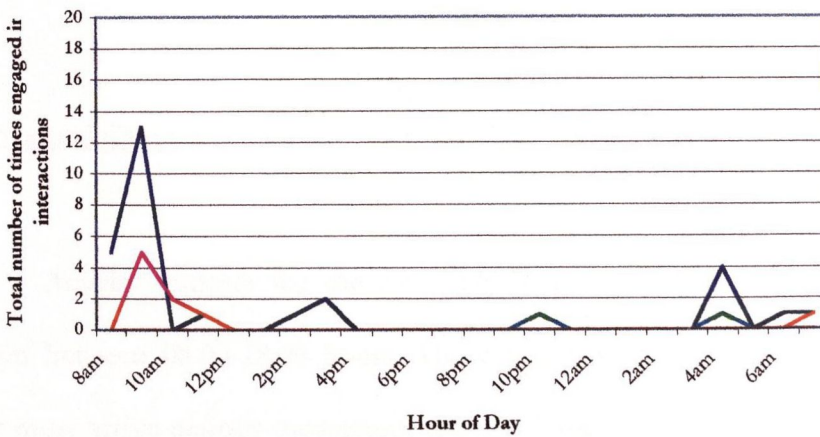


Fig 5.4b: Graph showing the total number of interactive advances made by the female toward the male over a 24-hour period.

Interactions

Figures 5.4a and 5.4b show the total number of interactions occurring between the individuals. Both graphs show that the majority of interactions occurred early in the morning between 07.00-09.00 hours and again mid afternoon between 13.00-15.00 hours, with a further small peak of interactions occurring between 04.00-06.00 hours. The graphs show that the male engaged in more interactive behaviour than the female. However, this difference lay in the fact that the female was usually the recipient of the male's interactive advances. This will be discussed further in section 5.4.

5.3.2 Seasonal Comparisons

Dublin Zoo

Behavioural Categories

Activity budgets for the two individuals were obtained during the summer season between 08.00-18.00 hours. These hours were chosen as a representation of their most active periods throughout their 24 hour activity budget, as demonstrated by their winter activity budgets. The main behaviours expressed were resting and feeding, just as they had been during the winter season. They also followed the same pattern of long bouts of rest followed by brief bouts of feeding and other activities.

Statistical analysis showed that like winter, there was no significant difference in the mean percentage time spent in each activity between the individuals, except for

sexual behaviour. There is a highly significant difference in the sexual behaviour between the male and female ($U=900$; $N=5,5$; $P=0.001$), with the male performing sexual behaviour at a higher rate than the female.

Diurnal activity budgets of both individuals were compared between seasons. Figures 5.5a and 5.5b show the mean percentage time spent in each activity for the male and female respectively, for both winter and summer.

Statistical analysis showed that there was no significant difference between winter and summer in amount of time spent feeding, resting, standing, locomoting or engaged in aggressive encounters in either individual.

In the male there was a highly significant increase in amount of time spent in exploratory behaviour ($U=708.5$; $N=5,5$; $P=0.001$) during the summer season. "Other" behaviours on the other hand showed a significant decrease in the summer ($U=970.5$; $N=5,5$; $P=0.05$). The female also showed a significant increase in exploratory behaviour ($U=797.5$; $N=5,5$; $P=0.001$), and a decrease in sexual behaviour ($U=1100$; $N=5,5$; $P=0.01$), during the summer season. Possible reasons for these differences will be discussed in section 5.4.

Area Usage

Figure 5.6 shows a highly significant decrease in the amount of time both individuals spend indoors between seasons, (male: $U=813.5$; $N=2,2$; $P=0.001$; female: $U=736.5$; $N=2,2$; $P=0.0001$), with both individuals spending less time indoors in the summer season. There was no significant difference in the amount of time spent indoors between the individuals.

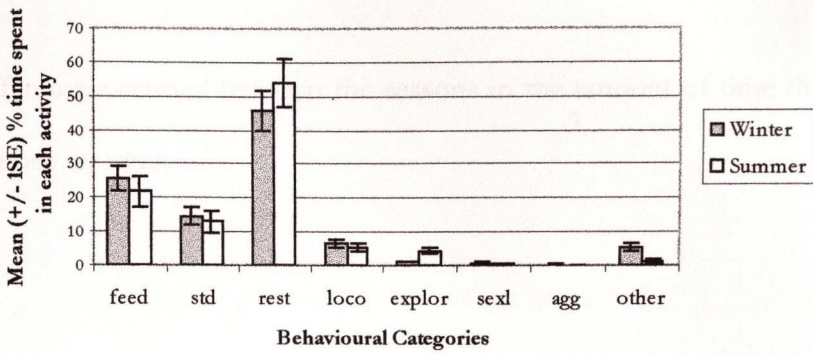


Fig 5.5a: Graph showing the percentage time spent in each activity for the male

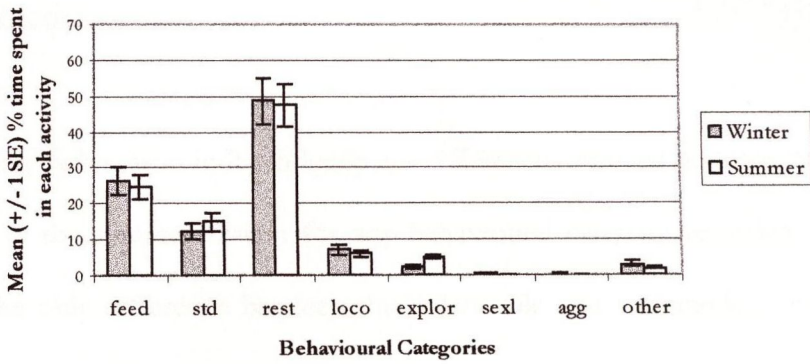


Fig 5.5b: Graph showing the percentage time spent in each activity for the female

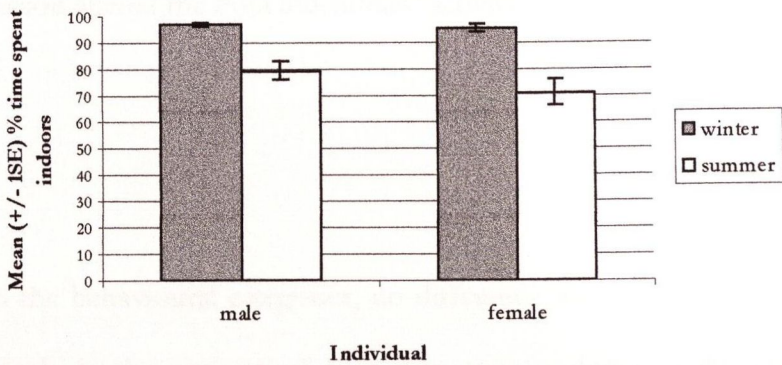


Fig 5.6: Graph showing seasonal differences in the amount of time spent indoors for both individuals

Proximity

No difference occurred between the seasons in the amount of time they spent in proximity to one another.

Fota Wildlife Park

Behavioural Categories

Examining each season independently, no difference occurred between the male and the female in the summer season for any behavioural category recorded. In the winter season the only difference between the individuals was for standing, with the female spending a significantly higher proportion of time standing than the male ($U=431$; $N=5,5$; $P=0.029$).

Comparing the activity budgets of the individuals between seasons, no difference was observed for any behavioural category for either individual. Hence, neither sex nor season altered the Fota individuals' activity budgets.

Area Usage

Similar to the behavioural categories, no difference was observed between the male and the female in the amount of time they spent indoors in the winter and summer seasons, respectively. However, comparing seasons the female spent a greater

proportion of her time indoors in the winter season ($U=404.5$; $N=5,5$; $P=0.009$), unlike the male who showed no difference between the seasons.

Proximity

Similar to the Dublin individuals, the Fota individuals demonstrated no difference in the amount of time they spent in proximity to one another between the seasons.

5.3.3 A Comparison Between the Zoos

Since no difference occurred between the individuals in each group, the males and females of each zoo were pooled and compared. Furthermore, since the Fota individuals were fed twice, once in the morning and once in the afternoon, and the Dublin individuals were fed in the morning only, overall data were separated into morning and afternoon data in order to establish where and why any difference occurred.

Dublin Winter Versus Fota Winter

When Dublin and Fota were compared for the winter season a variety of differences between the individuals were found (figure 5.7). Dublin individuals spent a

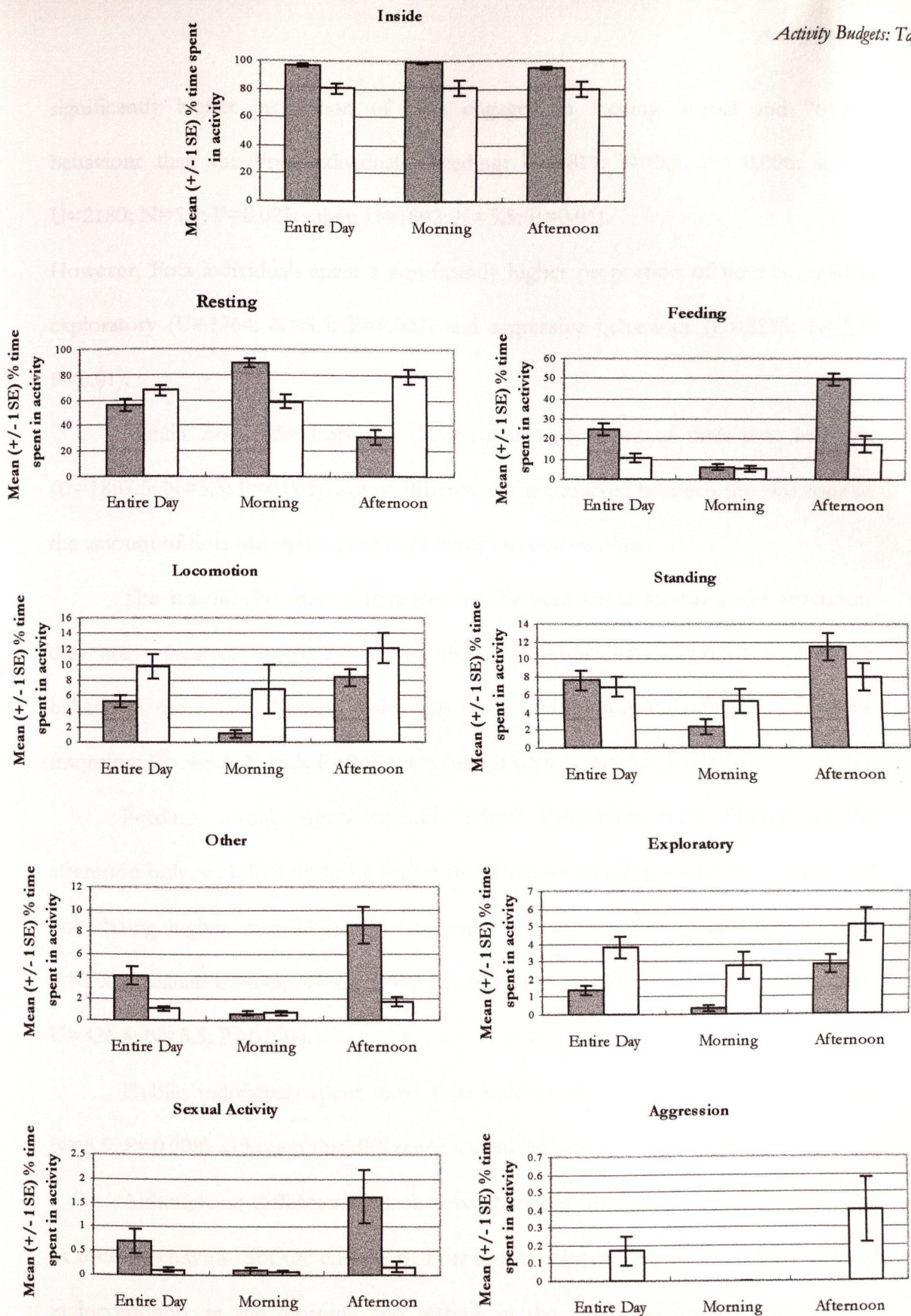


Fig 5.7: Graph showing a comparison of winter seasons between Dublin and Fota individuals

■ = Dublin □ = Fota

significantly higher proportion of time engaged in feeding, sexual and "other" behaviour than the Fota individuals, (feeding: $U=1811$; $N=5,5$; $P=0.006$; sexual: $U=2180$; $N=5,5$; $P=0.023$; other: $U=1892$; $N=5,5$; $P=0.01$).

However, Fota individuals spent a significantly higher proportion of time engaged in exploratory ($U=1764$; $N=5,5$; $P=0.002$) and aggressive behaviour ($U=2275$; $N=5,5$; $P=0.01$).

Dublin Zoo individuals also spent significantly more of their time indoors, ($U=1887.5$; $N=5,5$; $P=0.005$), but no difference was observed between the two zoos in the amount of time the tapirs spent in proximity to one another.

The reasons for these differences can be seen when morning and afternoon data are separated. Figure 5.7 shows that Fota individuals exhibited exploratory behaviour more than Dublin individuals both in morning and afternoon sessions (morning: $U=308.5$; $N=5,5$; $P=0.008$; afternoon: $U=601$; $N=5,5$; $P=0.046$).

Feeding, sexual, aggressive and "other" behaviours were different in the afternoon only, with Dublin being higher than Fota for feeding, sexual and "other" and Fota being higher than Dublin for aggressive behaviour (feeding: $U=408$; $N=5,5$; $P=0.001$; sexual: $U=643$; $N=5,5$; $P=0.026$; aggressive: $U=700$; $N=5,5$; $P=0.022$; other: $U=426.5$; $N=5,5$; $P=0.001$).

Dublin individuals spent more time indoors than Fota individuals ($U=316.5$; $N=5,5$; $P=0.008$), although this difference was significant in the morning only.

Although no difference was observed between the zoos for either locomotory or resting behaviour for the entire day, Fota spent a higher proportion of time engaged in locomotion, in the morning and resting, in the afternoon (locomotion: $U=332$; $N=5,5$; $P=0.038$; rest: $U=510$; $N=5,5$; $P=0.004$).

Dublin Summer Versus Fota Summer

During the summer seasons, a comparison between Dublin and Fota showed a number of differences (see figure 5.8). The Dublin tapirs exhibited standing, exploratory, sexual, and time indoors significantly more than Fota animals (stand: $U=1815.5$; $N=5,5$; $P=0.006$; explore: $U=1866$; $N=5,5$; $P=0.009$; sexual: $U=2240$; $N=5,5$; $P=0.013$; inside: $U=1951$; $N=5,5$; $P=0.028$). On the other hand, Fota exhibited resting behaviour and spent a greater proportion of time in proximity than the Dublin individuals (rest: $U=1928.5$; $N=5,5$; $P=0.025$; proximity: $U=1962$; $N=5,5$; $P=0.037$).

These differences between the two zoos lay predominantly in the afternoon (stand: $U=480$; $N=5,5$; $P=0.003$; rest: $U=534$; $N=5,5$; $P=0.015$; explore: $U=479$; $N=5,5$; $P=0.003$; sexual: $U=663$; $N=5,5$; $P=0.012$). Fota individuals spent a greater proportion of time in proximity in the morning session only ($U=314$; $N=5,5$; $P=0.017$).

Despite no overall difference being observed between Dublin and Fota individuals in the amount of time spent feeding, Dublin individuals spent a higher percentage of time feeding in the afternoon, compared to the Fota individuals ($U=577.5$; $N=5,5$; $P=0.045$).

Although no major differences were observed between the seasons for either Dublin or Fota, a comparison was made between the two zoos during opposite seasons. This was carried out because the condition of the females was the same in the different seasons, i.e. in the summer season the Dublin female was pregnant but it was the winter season when the Fota female was pregnant.

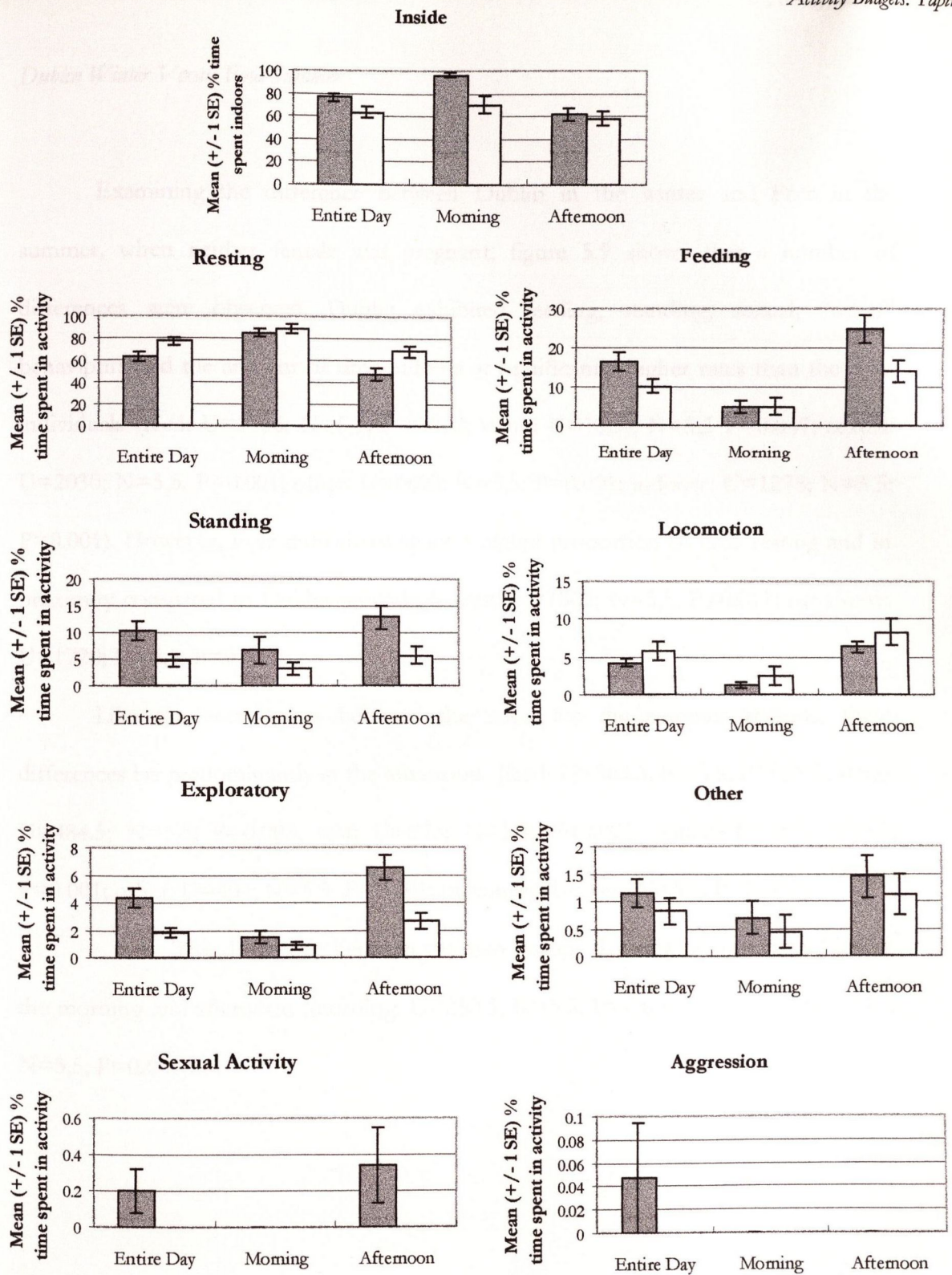


Fig 5.8: Graph showing a comparison of the summer seasons between Dublin and Fota

Dublin Winter Versus Fota Summer

Examining the difference between Dublin in the winter and Fota in the summer, when neither female was pregnant, figure 5.9 shows that a number of differences were observed. Dublin exhibited feeding, standing, sexual, "other" behaviours and the amount of time indoors at significantly higher rates than the Fota individuals (feed: $U=1736$; $N=5,5$; $P=0.002$; stand: $U=1864$; $N=5,5$ $P=0.047$; sexual: $U=2030$; $N=5,5$; $P=0.001$; other: $U=1692$; $N=5,5$; $P=0.001$; indoors: $U=1278$; $N=5,5$; $P=0.001$). However, Fota individuals spent a higher proportion of time resting and in proximity compared to Dublin individuals (rest: $U=1865$; $N=5,5$; $P=0.011$; proximity: $U=1720$; $N=5,5$; $P=0.002$).

Like the comparison between the zoos for the summer seasons, these differences lay predominantly in the afternoon (feed: $U=363.5$; $N=5,5$; $P=0.001$; stand: $U=484.5$; $N=5,5$; $P=0.003$; rest: $U=373$; $N=5,5$; $P=0.001$; sexual: $U=565$; $N=5,5$; $P=0.001$; other: $U=404$; $N=5,5$; $P=0.001$; proximity: $U=486$; $N=5,5$; $P=0.004$).

The difference between the two groups for area usage occurs both in the morning and afternoon (morning: $U=250.5$; $N=5,5$; $P=0.001$; afternoon: $U=374.5$; $N=5,5$; $P=0.001$).

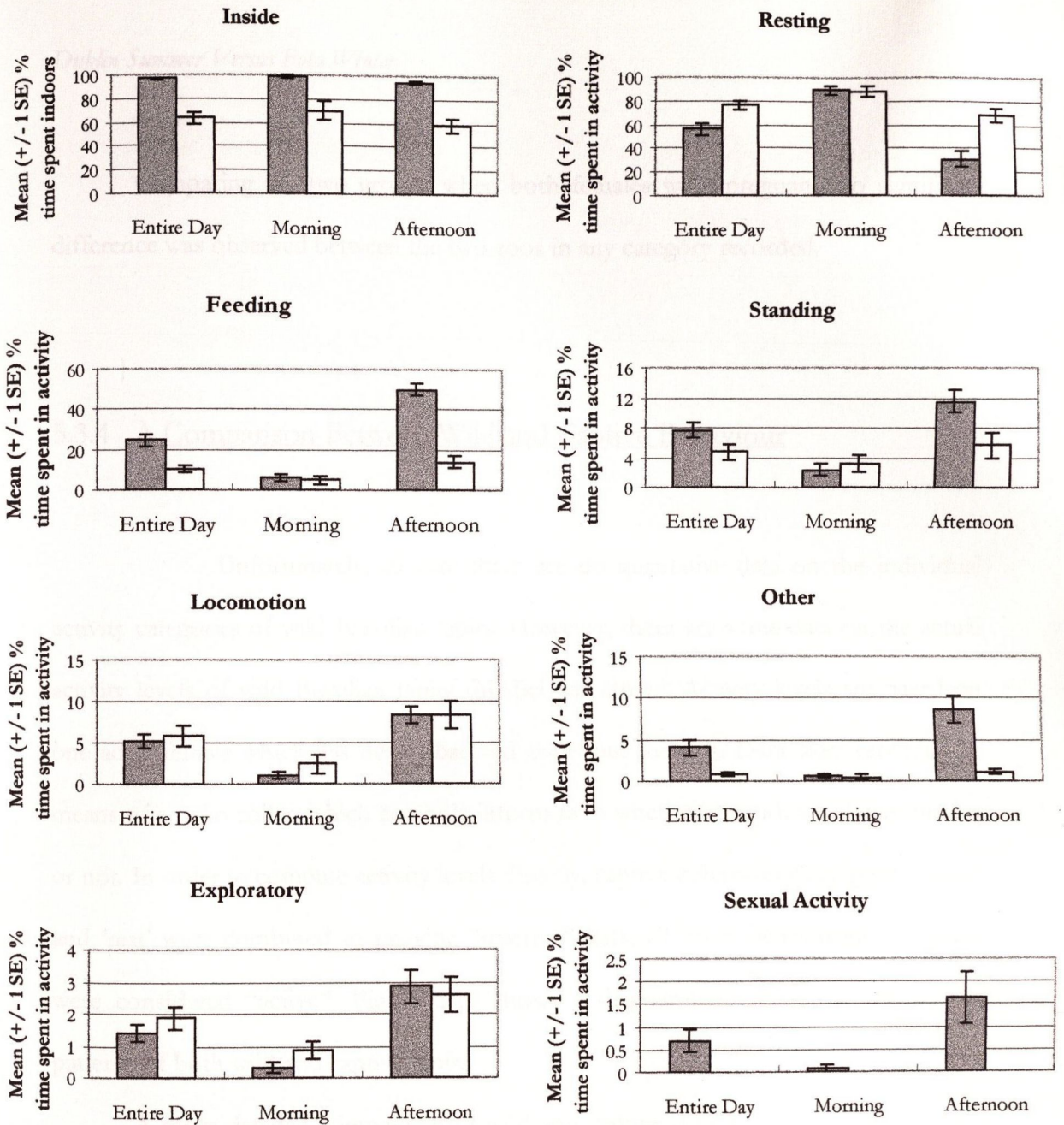


Fig 5.9: Graph showing a comparison between Dublin individuals in winter (Juvenile present) and Fota individuals in summer (no juvenile present). Note: The behavioural category aggression is missing from the graph as both zoos exhibited zero aggression.

■ = Dublin □ = Fota

Dublin Summer Versus Fota Winter

Comparing the two groups when both females were pregnant, no significant difference was observed between the two zoos in any category recorded.

5.3.4 A Comparison Between Wild and Captive Behaviour

Unfortunately, to date there are no quantitative data on the individual activity categories of wild Brazilian tapirs. However, there are some data on the actual activity levels of wild Brazilian tapirs (Medici *pers comm.*). Activity levels are based on one adult female which has been observed over four months. Data were recorded by means of a radio collar, which can only inform as to whether the individual was moving or not. In order to compare activity levels directly, captive behavioural categories 'stand' and 'rest' were combined to provide "inactive" data, all other behavioural categories were considered "active". Figure 5.10 shows a diagrammatic graph of the activity patterns of both wild and captive tapirs.

A more detailed comparison of wild and captive data will be made in the next section, 5.4.

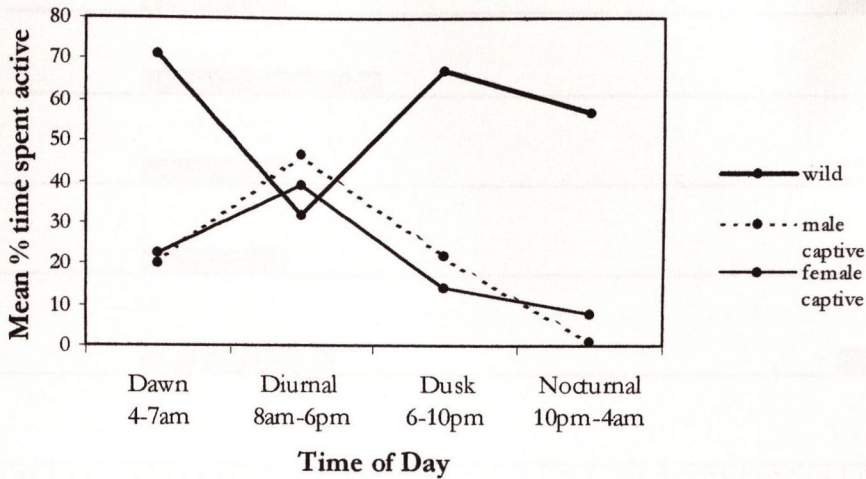


Fig. 5.10: Graph showing the mean percentage activity levels for wild and captive data over a 24 hour period

5.4 Discussion

5.4.1 Wild Versus Captive Behavioural Patterns

Over a 24 hour observation period tapirs demonstrated patterns of brief bouts of activity followed by long bouts of inactivity. Figure 5.11 shows a diagrammatic representation of activity levels over a 24 hour period for each of the five replicates. The diagram shows that bouts of activity occurred almost at the same time in each replicate. The greatest activity occurred between the hours of 07.00-10.00, 14.00-17.00 and again at 03.00-04.00, which remained consistent throughout all replicates.

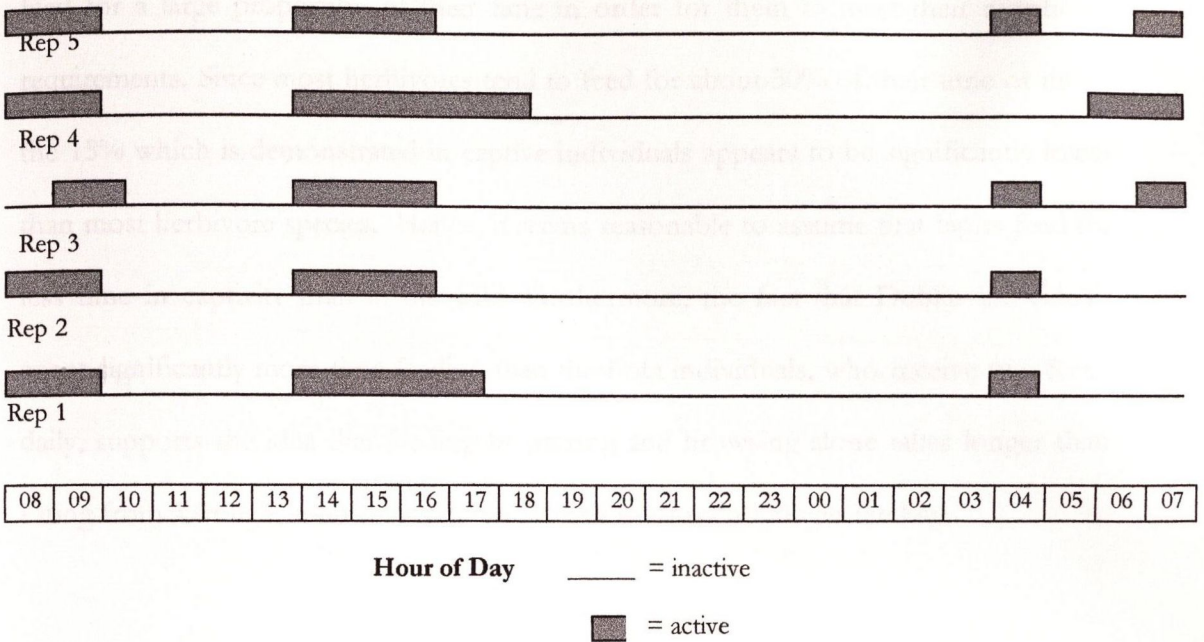


Fig 5.11: Diagram showing activity levels greater than 30 % for each hour over a 24 hour period, for each replicate.

If figure 5.10 is re-examined, it can be seen that in wild tapirs the lowest level of activity occurs diurnally between 08.00-18.00 hours, while in captivity this is when the highest peak of activity occurs. Furthermore, if dawn until dusk is examined the actual shape of the wild graph is a mirrored image of the captive one. This suggests that in captivity the tapirs alter their activity patterns probably to coincide with husbandry regimes particularly feeding times. In the wild the tapirs usually feed at dusk and dawn; in captivity however, the tapirs feed just after dawn in the early/ late morning.

Overall, captive tapirs are inactive for a higher proportion of their time than their wild counterparts. Despite not having data on the amount of time wild tapirs spend feeding, it seems reasonable to assume that captive individuals more than likely feed for significantly less time than their wild counterparts. Being herbivores they must

feed for a large proportion of their time in order for them to meet their nutritional requirements. Since most herbivores tend to feed for about 50% of their time or more, the 15% which is demonstrated in captive individuals appears to be significantly lower than most herbivore species. Hence, it seems reasonable to assume that tapirs feed for less time in captivity than in the wild. Furthermore, the fact that Dublin individuals spent significantly more time feeding than the Fota individuals, who receive two feeds daily, supports the idea that feeding by grazing and browsing alone takes longer than eating from a trough, so in the wild, the animals must spend longer feeding.

5.4.2 24 hour Activity Budgets

Over 24 hours no difference was observed between the individuals in any behavioural category except sexual behaviour, with the male engaging in more sexual activity than the female. The male is much more the pursuer of sexual behaviour, hence the male may be engaged in sexual activity whilst the female is not. An example of this is flehmen (when the male tastes the females' urine). In this instance it was only the males' behaviour which is recorded as sexual, the females would be recorded as standing or resting depending on her posture. The female could also be the sexual active individuals while the male was not, for example the female was often observed licking the males genitalia while he was resting. This may also account for why the male has a significantly greater number of interactions than the female. The large peak occurring at mid-afternoon (see figure 5.4a) saw an increase in all interactions for the male. The time before this peak was mainly when the tapirs were resting. After rest the male often engaged in grooming behaviour, which consisted of licking the female's eyes

clean, tactile behaviour such as the touching and rubbing of the female, and sniffing behaviour, the particularly of the female's genitalia. It should be noted that all bouts of vigorous interaction usually occurred just after rising from a period of rest. Usually after rest the male and female groomed each other and licked each others' eyes, presumably to clean them. The male also tended to be aroused post rest and often engaged in sexual interactions with the female, while she remained passive. Resting was the predominant behaviour expressed in the repertoire of these captive tapirs, followed by feeding, with other categories following significantly lower. Whether the high levels of resting behaviour observed in the animals suggests that this behaviour is important to the animals, or whether it is a "negative" behaviour due to lack of other stimuli, will be examined further in chapter 7.

5.4.3 Seasonal Comparisons

Comparing the Fota individuals' behavioural categories between seasons, no difference was observed for either individual. Furthermore, it has been document that very little variation in activity budgets actually occur in any species of tapir across seasons, or indeed across the species (Seitz *pers. com*). However, examining the differences between the seasons for the Dublin group some differences were observed. Both the male and female showed an increase in exploratory behaviour during the summer, but a decrease in "other" behaviours for the male and sexual behaviours for the female. In the Dublin individuals, the pair had a juvenile present in the winter but did not during the summer, hence differences observed in the Dublin individuals could attributed to the presence and absence of the juvenile rather than to be true seasonality.

In order to truly examine whether these differences were as a result of a juvenile being present and not to seasonality, a comparison between the zoos was made, where Fota individuals had no juvenile present at any time throughout observation, see section 5.4.4.

No difference was observed in the amount of time the individuals spent in proximity to one another between the seasons, however, both groups did show an increase in the amount of time they spent indoors during the winter season compared to the summer. The fact that all individuals spent more time indoors in the winter is not really surprising. During the winter the weather is colder and wetter, strong winds often prevail and so the individuals sought shelter indoors. These results suggest that unlike behavioural categories and proximity, the amount of time they spent indoors was seasonally dependant.

5.4.4 A Comparison Across Zoos

Table 5.1 provides a summary table of the difference between the two zoos across the seasons. It should be noted that during the winter seasons, the Fota female was pregnant and the Dublin group had a juvenile present. During the summer seasons the Dublin female was pregnant but the Fota female was neither pregnant nor had a juvenile present. The table and statistical analysis show that despite the seasons being different, when both conditions of the females were the same, no difference in any category was observed between the two zoos. In other words, when Fota winter and Dublin summer were compared no differences in any category were recorded.

	Dublin Winter (Juvenile) V's Fota Winter (Pregnant)	Dublin Summer (Pregnant) V's Fota Summer (No Juvenile /Not Pregnant)	Dublin Winter (Juvenile) V's Fota Summer (No Juvenile /Not Pregnant)	Dublin Summer (Pregnant) V's Fota Winter (Pregnant)
Feed	Dublin	NS	Dublin	NS
Stand	NS	Dublin	Dublin	NS
Rest	NS	Fota	Fota	NS
Loco	NS	NS	NS	NS
Explore	Fota	Dublin	NS	NS
Sexual	Dublin	Dublin	Dublin	NS
Aggressive	Fota	NS	NS	NS
Other	Dublin	NS	Dublin	NS
Indoor	Dublin	Dublin	Dublin	NS
Proxy	NS	Fota	Fota	NS

Table 5.1: Table showing a summary of the differences between the two zoos under each condition. The names in the table indicate which zoo was significantly higher than the other for a particular behaviour under a particular condition. NS = no significant difference was observed between the two zoos.

However, when the seasons were the same but the conditions of the females were different i.e when the pregnant Fota female (winter) was compared with the Dublin group, when a juvenile was present (winter), a variety of differences between the two zoos' activity budgets were observed. Dublin zoo expressed "other" behaviours such as interactions, at a higher rate than the Fota pair. When the juvenile was present, the individuals spent time engaged in play and in the pool with the juvenile, both of which were labelled 'other' behaviour. Hence, the higher occurrence of "other" behaviours. When the juvenile was absent, these behaviours became reduced and/or eliminated, and so, the individuals now had additional availability in their activity budgets to increase other behavioural categories, such as exploratory behaviour, which was higher in the Fota individuals.

These differences observed between Dublin and Fota in the winter, mirror the same differences between the Dublin individuals when comparing winter and summer seasons, or the presence and absence of a juvenile.

Based on the previous two comparisons it seems quite plausible to attribute any differences occurring between seasons in a group, to the presence or absence of a juvenile. In other words, when the females' reproductive status is similar, no difference occurs between the zoos. However, when the reproductive status of the females are different, no differences are observed despite the seasons being the same.

In addition to "other" behaviours and exploratory behaviour, when the winter seasons were compared, other differences did occur between the two zoos. These were differences which were not observed within each group between seasons, but have been observed only across zoos, such as feeding. This suggests that other behavioural differences occurring between the zoos, apart from "other" and exploratory behaviours, may be due to other factors and not solely down to whether a juvenile is present or not.

In the winter season when Dublin and Fota were compared, in addition to the differences between them as described above, it can be seen that Dublin individuals engaged in feeding and sexual behaviour more, and spent more time indoors than the Fota individuals, whereas Fota individuals exhibited increased aggression at significantly higher levels compared to the Dublin group.

If sexual behaviour and the amount of time spent indoors is examined throughout table 5.1, it can be seen that for these behaviours Dublin individuals had higher levels across all seasons and conditions. Since both husbandry regimes were similar, except for Fota receiving two feeds daily, and both have 24 access to their outside paddock, these differences may be purely due to individual preference.

When Fota individuals were observed, the female was quite heavily pregnant and was showing higher levels of aggression than the Dublin individuals. Female tapirs are renowned aggressors when they are close to giving birth. The fact that higher levels of aggression were not observed in the Dublin female when she was pregnant could be due to the fact that she was much earlier along in her pregnancy during observations and hence, did not exhibit higher aggression levels. Additionally, the fact that the Fota juvenile died when just a few days old could also suggest that the female may have been in discomfort throughout the pregnancy and hence a lot more aggressive interactions were observed between the individuals. This would account for why in all other seasons and comparisons, no difference in the aggression levels between the two zoos were observed, a difference was only observed comparing Dublin winter and Fota winter.

Looking at table 5.1, during the winter Dublin individuals spent significantly more time feeding than the Fota individuals both in winter and summer. Since no difference in feeding levels occurred between seasons within each zoo, it can only be assumed that these differences are attributed to differences between the zoos, and not whether a juvenile was present or not and whether a pregnancy was underway. These results are surprising because Fota individual were fed twice daily, once in the morning and once in the afternoon, whereas Dublin individuals were fed once only, in the morning. Both groups were provided with ad lib food and had access to a large grassy paddock 24 hours a day. In both conditions these differences in feeding occurred in the afternoon only. Since the differences occurred in the afternoon and Fota were the group which were fed in afternoon session and since the only obvious difference in their husbandry regime is the occurrence of additional feeding in Fota, it would be

expected that it would be the Fota group that demonstrated feeding behaviour more. However, this was not the case. So where does this difference lie?

Dublin individuals spent a good proportion of their afternoon grazing and browsing. Fota individuals were seldom, if ever, observed to graze, despite having a large grassy paddock available to them. Fota individuals were bulk fed in the afternoon and so could gain additional nutrition in a short time. Because the Dublin individuals were not receiving a high nutritional diet in the afternoon, they spent longer feeding from browse and grass to obtain these nutrients. The fact that Dublin fed for a greater time winter season only, compared to Fota may be due to the availability of browse, or the fact that the female was pregnant.

Browse has a higher nutritional content than grass, and so in the afternoons during winter when browse was not available, the Dublin individuals had to eat far more grass to obtain sufficient nutrients. In the summer when more browse was available, the individuals could feed for less time to obtain the same amount of nutrients, hence no difference was observed for feeding between Dublin in the summer and Fota in either season.

When Fota summer data were compared to both Dublin winter and summer, additional differences between the zoos were observed. From table 5.1 it can be seen that Dublin individuals spent more time standing both in winter and summer than the Fota group during the summer. Conversely, Fota individuals spent a greater amount of time resting than the Dublin pair in both seasons.

Both standing and resting are inactive behaviours. Although standing does require an increase in basal metabolic rate, the fact that the animal was motionless, led to this behaviour being considered inactive. If both categories are combined, the

amount of time both groups spent actually inactive are not different. These differences observed are down to posture preference only. During the summer months the Fota individuals did tend to lie outdoors more than the Dublin group. The Dublin group very rarely were observed lying down in their outside enclosure in either season, and would usually stand. Therefore, it is highly likely that these differences that occurred are due to no other factors other than individual preferences.

This reasoning may be also applied to the longer time the Fota individuals spent in proximity to one another in the summer seasons, than the Dublin pair in either season. However, it should be noted that the Fota individuals had just recently lost a baby and so, perhaps in some way this encouraged the pair to spend more time with one another. Additionally, perhaps the female was coming back into season and the male was guarding her.

Finally, locomotion was the only behavioural category that exhibited no difference between the zoos for any combination of comparisons. Locomotion appears to be the only behavioural category which did not seem to be affected by any factors, be it the reproductive status of the female, season, zoo or husbandry regime.

5.4.5 Summary

A thorough examination of the activity budgets of two groups of captive lowland tapirs was conducted. Tapirs have activity budgets which vary surprisingly little across individuals, seasons and even zoos. In fact it has been noted that very little behavioural variation actually occurs across species as well (Seitz *pers.com*).

Any differences that may be observed between different zoos or seasons appear to be due to a variety of different factors depending on the behavioural category.

Behaviours, such as exploratory and "other" behaviours appear to be affected by the presence or absence of a juvenile. On the other hand, behaviours such as feeding tend to be affected by husbandry regime. Postural positions, such as whether an individual stands or lies appears to be due to group preference, as both individuals in a pair exhibited the same preference, although sample sizes were too small to be truly categorical about this.

The amount of time the individuals spent indoors is the only seasonally dependant category in their activity budgets.

Tapirs are largely crepuscular in the wild. In captivity they also exhibited an activity cycle, the opposite to that which was found in the wild. Their high levels of activity occurring nocturnally in the wild appear to be displaced to the daytime in captivity. This is more than likely attributed to their husbandry regime and times of feeding in captivity.

Although no quantitative data exists with which to compare wild and captive behaviour, it does seem plausible to assume that captive tapirs are behaving differently from their wild counterparts, mainly by demonstrating lower feeding and overall activity levels, as well as the time of day for these activities.

Chapter Six

ACTIVITY BUDGETS: GIRAFFES

6.1 Introduction

Unlike tapirs, the behaviour of giraffes in the wild is well documented (Dagg & Foster 1976; Pellew 1984; Veasy *et al.* 1996). Giraffes are also well studied in captivity (Coe 1967; Dagg 1970; Koene & Visser 1996)(see section 1.13 in chapter 1). Like the tapirs, giraffe captive studies are also based largely on certain hours in the day. Veasy *et al.* (1996), conducted nocturnal studies on captive giraffe, however, nocturnal data was based on two hours only. This project examines the activity budgets of captive giraffe in detail both diurnally and nocturnally. It examines whether any behavioural differences occur between the sexes and how behaviour is affected by three very different enclosures. Finally, the behaviour of captive and wild giraffe are compared.

6.2 Method

Like the tapirs, giraffe data were obtained using 30-second group scan sampling. Their checksheet (see Appendix 1b) comprised of 11 behavioural categories (see Appendix 2b for ethogram of behaviours).

Data were obtained diurnally across three different enclosures through direct observation. Nocturnal data were obtained using a video camera and an infra red light which was installed in the night time quarters of the giraffes. Data were then analysed from the video tapes.

Diurnal data were recorded between the hours of 10.00 and 16.00 hours, as this was the time span which remained consistent across the enclosures for minimum husbandry interference. Nocturnal data were collected between the hours of 16.00 and 08.00 hours, data was obtained when the individuals had spent the day indoors. No data was recorded between the hours of 08.00 and 10.00 as these hours were usually interrupted by the husbandry regime. As with the tapirs 5 replicates of each hour of observation were made. Data were statistically examined using the methods described in chapter 4, section 4.3/4.4.

See chapter 3, for enclosure dimensions. The three enclosures utilised for this study were:-

ENCLOSURE 1: *Inside Enclosure*

This enclosure was used for the nocturnal study and one of the diurnal studies. In the winter, during extreme weather, the giraffes were usually housed in this enclosure during the day. This was the same enclosure as their night time quarters. It consisted of two stalls next to each other, one for the male and one for both females. Although in separate stalls the giraffes could still see and come into contact with each other by leaning over the barrier. The stalls comprised an area which had straw bedding, a hay rack, a salt lick and a drinking trough. In this enclosure they had no access to browse and were fed at approximately 14.00 hours a

mixture of fruit and vegetables as well as fibre and protein supplements. Nocturnal data was obtained

ENCLOSURE 2: *Old Outside Enclosure*

This enclosure was the giraffes' old enclosure before they were released into the new African Plains exhibit. They were housed in enclosure 2 diurnally during good weather, and were brought into enclosure 1 nocturnally. This paddock comprised of an area with grass surrounding the edge of the enclosure. In the centre of the enclosure the substrate was muddy and contained a tree which was fenced off, so the giraffes could not strip the bark. This enclosure also had a hay rack and a water trough. The giraffes were provided with browse, hung from browse poles, usually in the morning. In the evenings when they were brought in they were fed a mixture as described above.

ENCLOSURE 3: *African Plains*

In July 2000, the giraffes were moved to a new enclosure called the "African Plains". This enclosure was the biggest of the three enclosures and consisted of a large grassy field. In addition to the extra area, the giraffes were housed with an additional three giraffes (2 females and 1 juvenile male) as well as Ostrich, Zebra and Oryx. This enclosure was the most "naturalistic" enclosure of the three enclosures examined. At night time usually between 16.00 and 17.00 hours, the giraffes were moved into their new inside area. Data was not collected in this enclosure.

6.3 Results

6.3.1 Diurnal Enclosures Compared

Figure 6.1 shows the difference between enclosures for each individual, for each behavioural category recorded. Table 6.1a-c (Appendix 3) gives all post hoc information including the critical difference between the categories for each individual.

The male showed no difference in feeding or foraging behaviours between any of the enclosures, however, both females did exhibit differences in the amount of time they spent in these activities. Both females spent more time foraging in enclosure 2 than enclosure 1 (F_1 : $\chi^2 = 7.268$; $df=2$; $P=0.026$; F_2 : $\chi^2 = 11.157$; $df=2$; $P=0.004$), similar differences were also observed for the F1 female in the amount of time spent feeding ($\chi^2 = 13.603$; $df=2$; $P=0.001$). The F2 female on the other hand spent more time feeding in enclosure 3 than either of the other two enclosures ($\chi^2 = 10.876$; $df=2$; $P=0.004$) (see figure 6.1a Appendix 3).

All three individuals demonstrated differences between enclosures in the amount of time they spent engaged in licking behaviour, tongue playing, standing, locomotion, rumination and "other" behaviours. The male and both females spent significantly less time performing licking and tongue playing behaviour in enclosure 3 compared to the other two enclosures. In the male this difference occurred between all enclosures (*Licking*: $\chi^2 = 35.667$; $df=2$; $P<0.001$; *Tongue playing*: $\chi^2 = 51.910$; $df=2$; $P<0.001$) (see figure 6.1a Appendix 3). In the females, licking

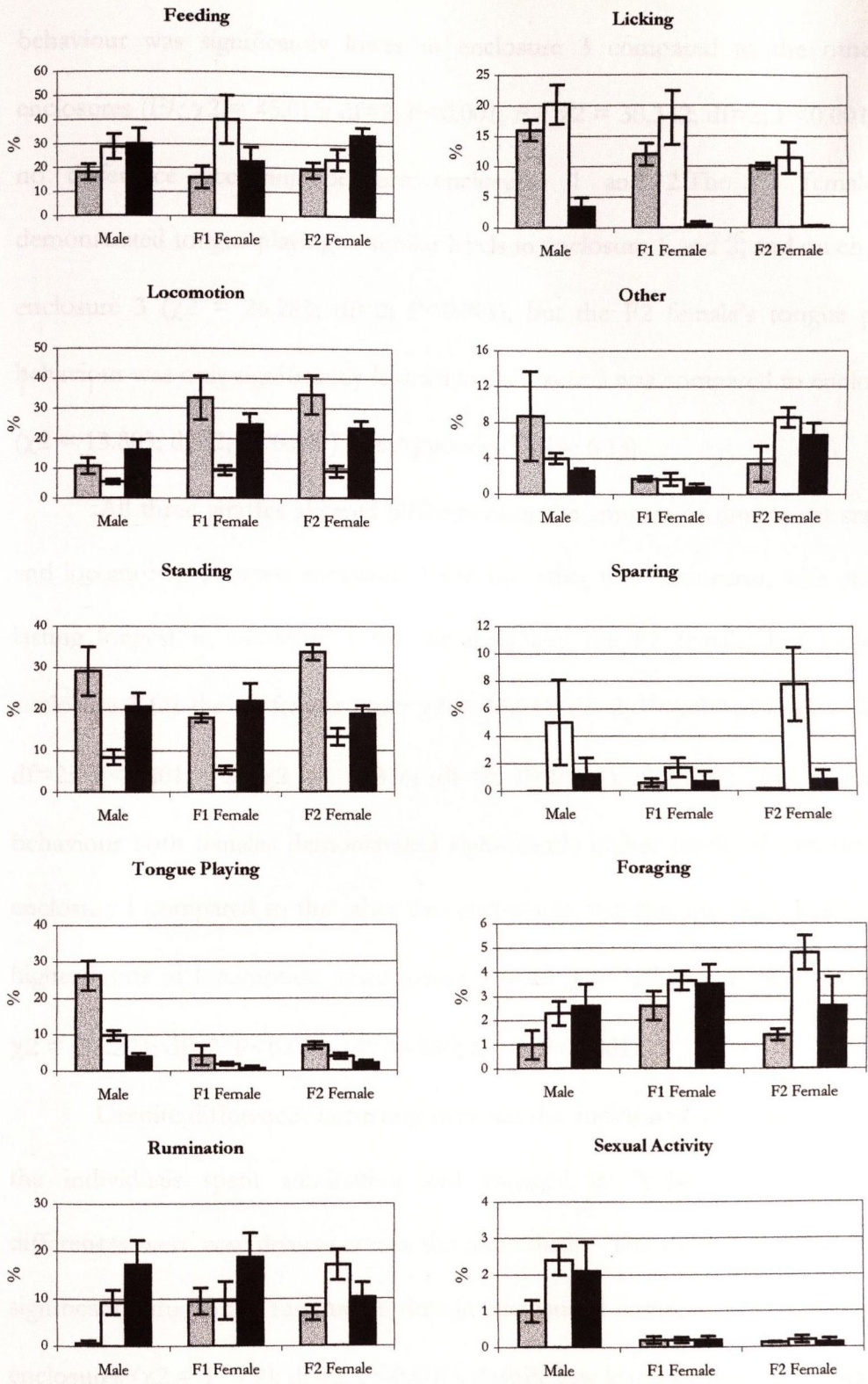


Fig. 6.1: Graph showing the difference between the enclosures in each behavioural category for each individual

■ = Enclosure 1 □ = Enclosure 2 ■ = Enclosure 3

behaviour was significantly lower in enclosure 3 compared to the other two enclosures ($F1: \chi^2 = 45.015; df=2; P<0.001; F2: \chi^2 = 38.342; df=2; P<0.001$), with no difference occurring between enclosures 1 and 2. The F1 female also demonstrated tongue playing at similar levels in enclosure 1 and 2, and much less in enclosure 3 ($\chi^2 = 26.283; df=2; P<0.001$), but the F2 female's tongue playing behaviour was only significantly less when enclosure 3 was compared to enclosure 1 ($\chi^2 = 13.803; df=2; P<0.001$) (see Appendix 3 table 6.1a).

All three giraffes showed differences in the amount of time spent standing and locomoting between enclosure 2 and the other two enclosures, with standing lasting longest in enclosure 1 for the male and the F2 female, but longest in enclosure 3 for the F1 female (*male*: $\chi^2 = 33.031; df=2; P<0.001; F1: \chi^2 = 42.969; df=2; P<0.001; F2: \chi^2 = 15.376; df=2; P<0.001$). Similarly, for locomotory behaviour both females demonstrated significantly higher levels of locomotion in enclosure 1 compared to the other two enclosures, whereas the male demonstrated higher levels of locomotion in enclosure 3 (*male*: $\chi^2 = 27.735; df=2; P<0.001; F1: \chi^2 = 33.293; df=2; P<0.001; F2: 39.986; df=2; P<0.001$).

Despite differences occurring between the enclosures in the amount of time the individuals spent ruminating and engaged in "other" behaviours, these differences were very diverse across the individuals. The male showed a large and significant reduction in rumination time in enclosure 1 compared with the other two enclosures ($\chi^2 = 17.750; df=2; P<0.001$), despite low levels of rumination occurring in the male in enclosure 1, it should be noted that rumination occurred nocturnally instead (see section 6.4 for further discussion). He also exhibited "other" behaviours less in enclosure 3, than the other two enclosures ($\chi^2 = 10.424; df=2; P=0.005$). The F1 female demonstrated a higher level of ruminating and a lower level of

“other” behaviours in enclosure 3 compared to enclosure 1 (*ruminat*ion: $\chi^2 = 6.698$; $df=2$; $P=0.035$; *other*: $\chi^2 = 7.588$; $df=2$; $P=0.023$). Conversely, the F2 female demonstrated most rumination and her highest occurrence of “other” behaviours in enclosure 2 compared to enclosure 1 (*ruminat*ion: $\chi^2 = 15.683$; $df=2$; $P<0.001$; *other*: $\chi^2 = 9.740$; $df=2$; $P=0.008$).

Both the male and the F2 female engaged in sparring matches at higher levels in enclosure 2, compared to enclosure 1 in the male, and compared to both 1 and 3 in the F2 female (*male*: $\chi^2 = 21.108$; $df=2$; $P=0.005$; *F2*: $\chi^2 = 6.883$; $df=2$; $P=0.032$). The F1 female demonstrated no difference between the enclosures for sparring behaviour.

The final behavioural category examined was sexual activity. A difference was observed between the enclosures only for the male, who spent more time engaged in sexual activity in enclosure 2 than enclosure 1 ($\chi^2 = 14.16$; $df=2$; $P=0.001$).

A full discussion of these results will take place in section 6.4.

6.3.2 Nocturnal Behaviour

Figures 6.2a-c show the mean time \pm 1SE, each individual spent in each activity recorded during nocturnal hours as detailed above. When examining the nocturnal behaviour of the giraffes, three new behavioural categories were included, these were lying - which is recorded as such when the giraffes were lying with their heads erect; sleeping - when the giraffes were lying with their heads resting on their flanks and unknown - when the giraffes were out of the range of the video and could not be seen. From the graphs 6.2a-c, and table 6.2 showing the actual means,

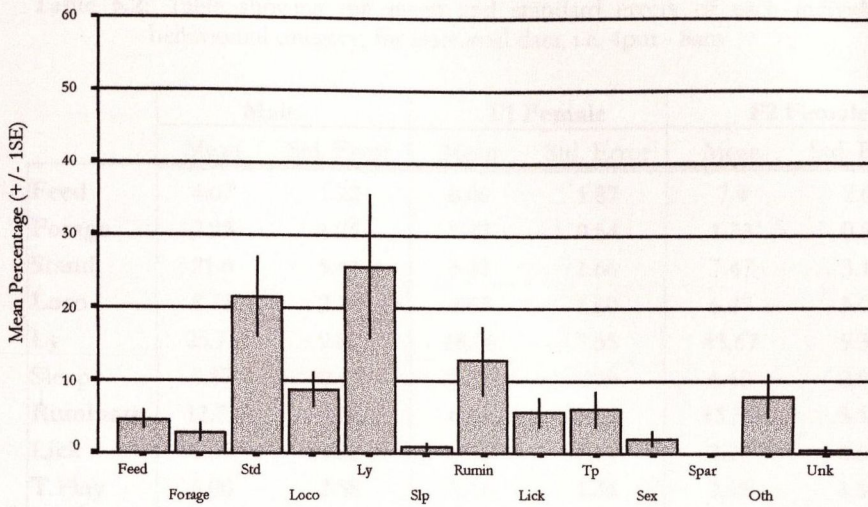


Fig 6.2a: Graph showing the mean percentage time spent in each activity for the male giraffe

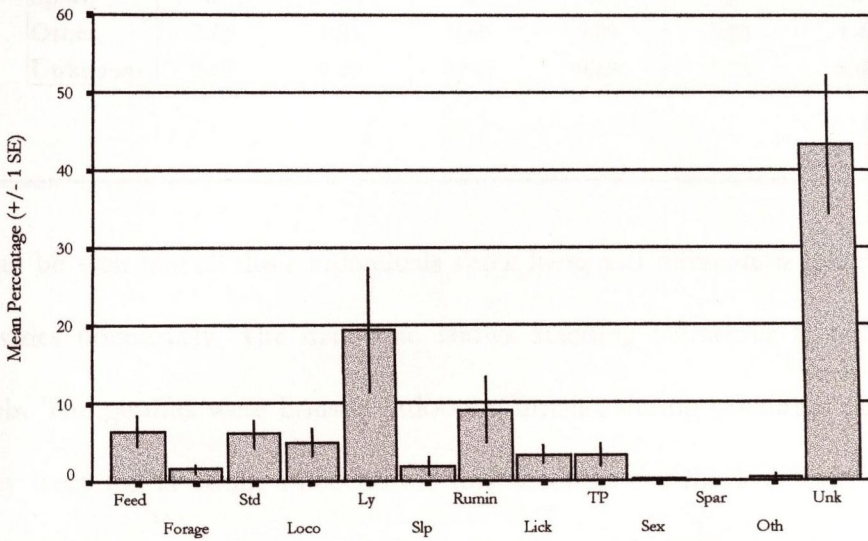


Fig 6.2b: Graph showing the mean percentage time in each activity for the F1 female

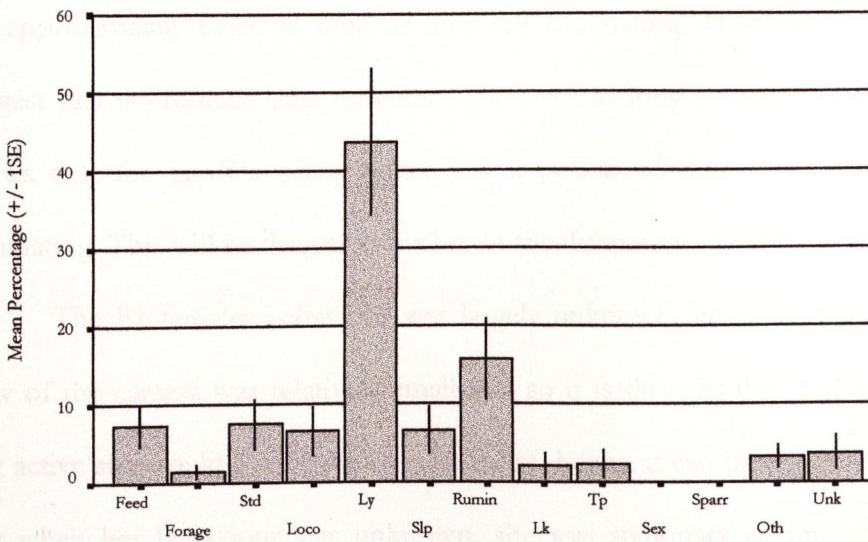


Fig 6.2c: Graph showing the mean percentage time in each activity for the F2 female

Abbreviations: Std= stand; Loco=locomotion; Slp= sleep; Rumin= rumination; Lk=licking; Tp=tongue playing; Sex= sexual activity; Spar= sparring; Oth=other; Unk= Unknown

Table 6.2: Table showing the mean and standard errors of each individual for each behavioural category, for nocturnal data, i.e. 4pm - 8am

	Male		F1 Female		F2 Female	
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Feed	4.67	1.22	6.00	1.87	7.4	2.65
Forage	2.93	1.26	1.47	0.54	1.33	0.82
Stand	21.6	5.44	5.67	1.66	7.47	3.10
Loco	8.73	2.26	4.67	1.60	6.47	3.03
Ly	25.73	9.89	18.06	7.55	43.67	9.39
Sleep	0.87	0.42	1.80	0.99	6.60	2.98
Ruminate	12.73	4.72	8.46	3.89	15.80	5.10
Lick	5.66	1.88	3.38	1.19	2.00	1.68
T.Play	6.00	2.38	3.13	1.36	2.33	1.65
Sex. Act	2.00	1.01	0.13	0.13	0	0
Sparr	0	0	0	0	0	0
Other	7.93	2.85	0.40	0.29	3.20	1.43
Unknown	0.40	0.40	47.07	9.19	3.73	2.09

it can be seen that all three individuals show lying and rumination to be their main activities nocturnally. The male also shows standing behaviour at relatively high levels. The giraffes were housed indoors diurnally, during nocturnal observations. They were fed at about 14.00 hours, this accounts for the low levels of feeding observed nocturnally by all the individuals. Figure 6.1 shows that the animals feed for approximately twice as long as they did ruminating. However, figures 6.2a-c suggest that nocturnally they ruminated for twice as long as they did feeding. This shows that the giraffes often waited for a period of time post feeding before ruminating. This will be discussed further in the discussion section.

The F1 females behaviour was largely unknown, however, the area out of view of the camera was relatively small and so it is thought that if she was in any way active she would have been in view more, hence, it can be reasonably assumed that when her behaviour was unknown, she was stationary so probably lying or sleeping. All other behavioural categories recorded in the individuals occurred for less than 10% each in their night time activity budgets.

A further discussion of their nocturnal behaviour and its relationship to diurnal behaviour will be examined in section 6.4.

6.3.3 A Comparison Between Individuals

Figures 6.3-6.6 show a comparison between the individuals for each behavioural category in each enclosure. Each enclosure will be examined independently, with a full discussion the results occurring in section 6.4.

Enclosure 1 (Indoor Enclosure/Nocturnal enclosure)

Examining the differences between the individuals in their inside enclosure a number of categories were seen occurring at different levels among the three giraffes (figure 6.3). The male exhibited locomotion less ($\chi^2 = 33.713$; $df=2$; $P<0.001$), and tongue playing more than either female ($\chi^2 = 45.137$; $df=2$; $P<0.001$) (see Appendix 3 table 6.2 for all critical differences and post hoc results). The male also exhibited “other” behaviours more frequently ($\chi^2 = 9.984$; $df=2$; $P=0.007$) and rumination less ($\chi^2 = 9.552$; $df=2$; $P=0.008$) than the F1 female only.

The F2 female spent less time engaged in licking behaviour than either the male or the F1 female ($\chi^2 = 23.812$; $df=2$; $P<0.001$) and less time in sexual activity than the male ($\chi^2 = 13.635$; $df=$; $P=0.001$).

In addition to the giraffes being housed in enclosure 1 diurnally during the winter, they were also housed in this enclosure nocturnally all year round. Figure 6.4 shows the difference occurring between the individuals’ nocturnal activity budgets. As seen in their diurnal activities, a difference occurred between the individuals in

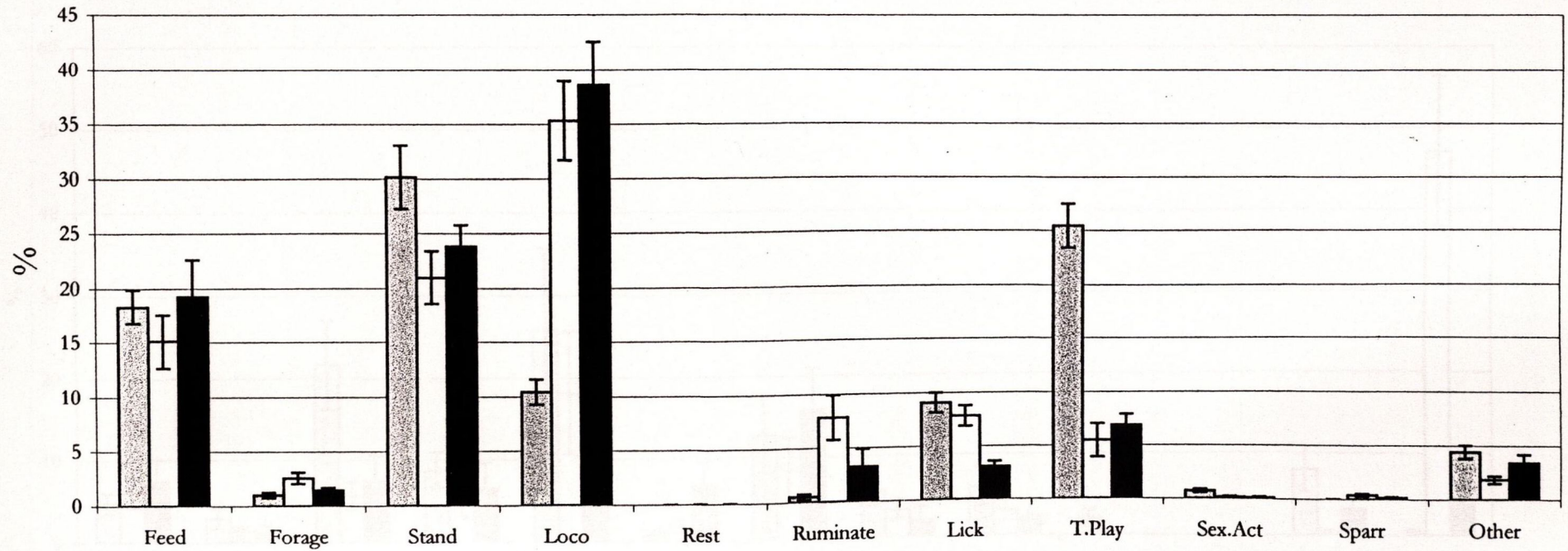


Fig 6.3: Graph showing the difference between the individuals for each behavioural category in ENCLOSURE 1

= Male
 = F1 Female
 = F2 Female

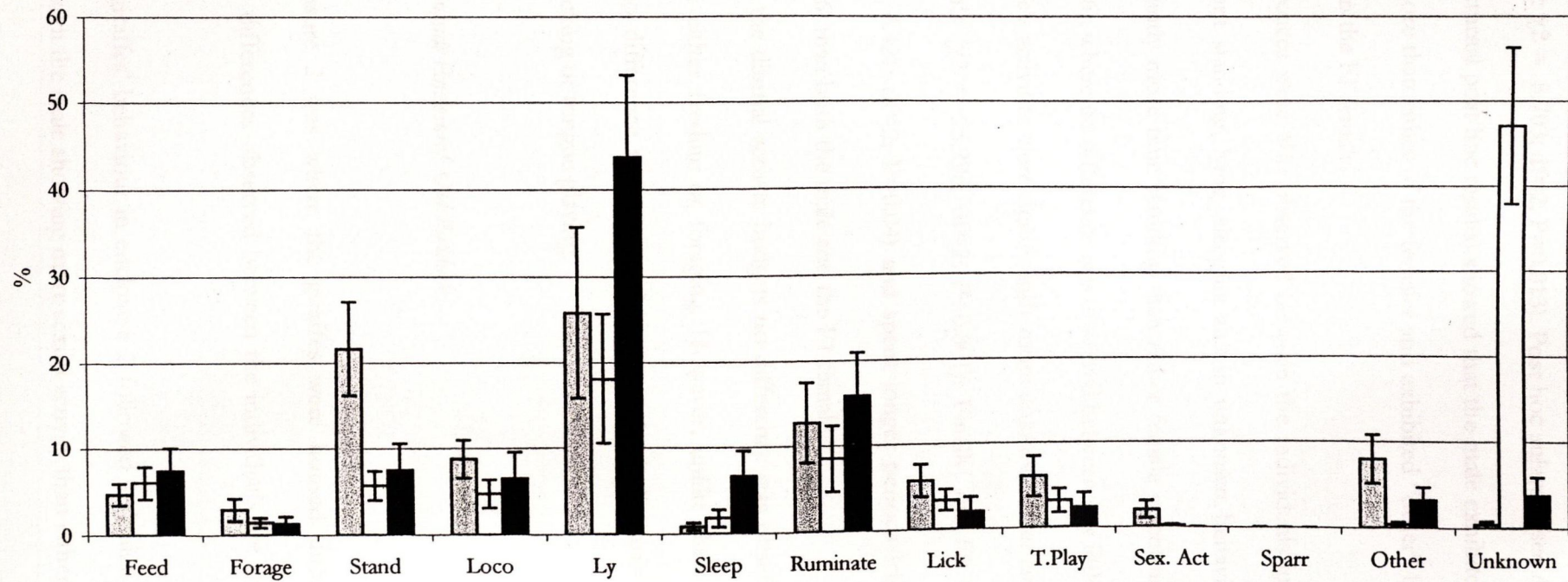


Fig 6.4: Graph showing the difference between the individuals in each behavioural category for nocturnal activity

= Male
 = F1 Female
 = F2 Female

sexual and “other” behaviours for their nocturnal budgets (*sex*: $\chi^2 = 8.254$; $df=2$; $P=0.016$; *other*: $\chi^2 = 8.703$; $df=2$; $P=0.013$). Post hoc analysis (see Appendix 3 table 6.3 for all nocturnal post hoc results) showed that the male exhibited sexual activity nocturnally more than either of the females and exhibited “other” behaviours more frequently than the F1 female.

Differences were also observed between the individuals in the amount of time they spent standing, lying, sleeping and in unknown behaviours. The male spent significantly more time standing than either female nocturnally ($\chi^2 = 3.306$; $df=2$; $P=0.026$), where no difference was observed between any individual diurnally. The F1 female’s activities were significantly more unknown than either of the other two individuals ($\chi^2 = 25.296$; $df=2$; $P<0.001$). Finally, the F2 female slept for longer ($\chi^2 = 6.421$; $df=2$; $P=0.04$) and spent longer periods lying ($\chi^2 = 7.268$; $df=2$; $P=0.026$) than both the male and the F1 female.

As in the diurnal activity budgets no difference was observed between the individuals in either feeding or foraging. However, unlike their diurnal budgets, nocturnally no difference was observed between the individuals for locomotion, rumination, licking or tongue playing.

Enclosure 2 (Outside Enclosure/ Old Paddock)

Enclosure 2 was where the giraffes were housed during warmer drier weather. The differences observed between the individuals are illustrated in figure 6.5.

The giraffes’ behaviour in enclosure 2 followed a similar pattern to that in enclosure 1, with the male showing more sexual activity than either female, and

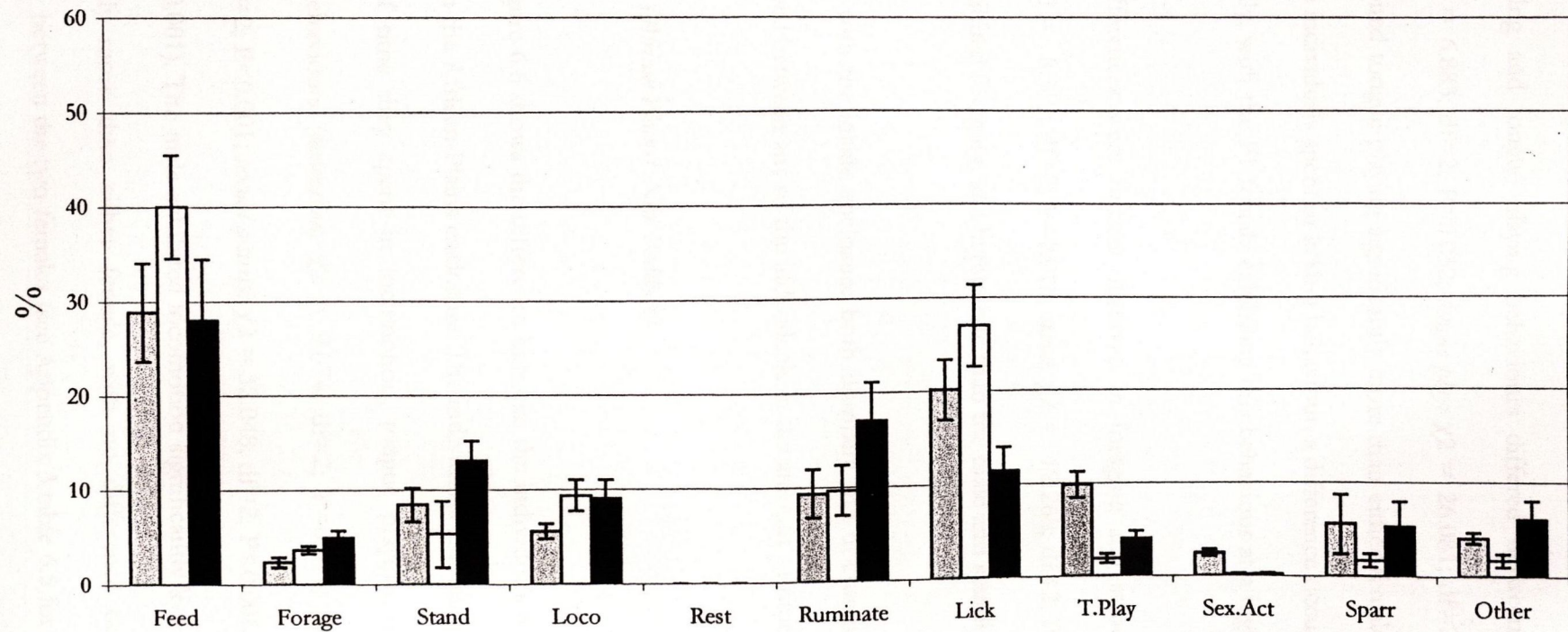


Fig 6.5: Graph showing the difference between the individuals for each behavioural category in ENCLOSURE 2

= Male
 = F1 Female
 = F2 Female

more "other" behaviours than the F1 female (*sex*: $\chi^2 = 50.568$; $df=2$; $P<0.001$; *other*: $\chi^2 = 28.344$; $df=2$; $P<0.001$) (see Appendix 3, table 6.4 for all critical differences).

Again licking and tongue playing behaviours differed between the individuals (*licking*: $\chi^2 = 6.883$; $df=2$; $P=0.032$; *tongue play*: $\chi^2 = 26.081$; $df=2$; $P<0.001$). The male exhibited tongue playing significantly more than either female. In the amount of time the individuals spent in licking behaviour, a difference occurred between the females only, with the F1 female exhibiting this behaviour at a higher rate than the F2 female.

Differences were further observed in foraging and standing behaviours, (*foraging*: $\chi^2 = 8.319$; $df=2$; $P=0.016$; *stand*: $\chi^2 = 12.268$; $df=2$; $P=0.002$). The F2 female exhibited foraging at a higher rate than the male and standing more than the F1 female.

As with the inside enclosure both diurnally and nocturnally, no difference was observed between any of the individuals in the amount of time spent feeding.

Enclosure 3 (African Plains/ New Paddock)

Figure 6.6 shows the difference between the individuals in their behavioural activities in the African Plains enclosure. The individuals exhibited differences in the amount of time they spent in locomotion, tongue playing, sexual activity and "other" behaviours (*locomotion*: $\chi^2 = 9.074$; $df=2$; $P=0.011$; *tongue playing*: $\chi^2 = 16.987$; $df=2$; $P<0.001$; *sexual activity*: $\chi^2 = 32.048$; $df=2$; $P<0.001$; *other*: $\chi^2 = 16.22$; $df=2$; $P<0.001$). The male exhibited locomotion significantly less but sexual activity significantly more than either female, with no difference occurring in either behaviour between the two females (see Appendix 3 table 6.5 for all post hoc

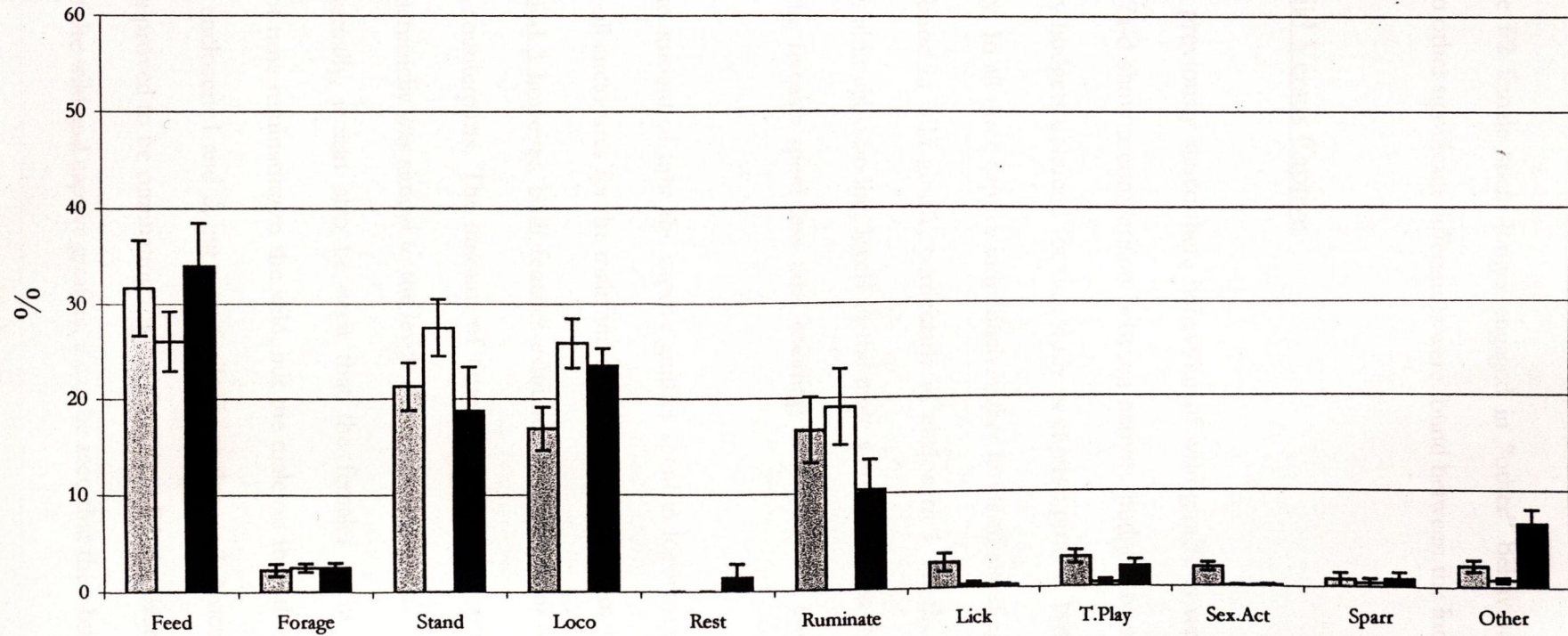


Fig 6.6: Graph showing the difference between the individuals for each behavioural category in ENCLOSURE 3

■ = Male

□ = F1 Female

■ = F2 Female

results). The male also demonstrated tongue playing significantly more than the F1 female.

The F2 female spent longer engaged in "other" behaviours than the F1 female. No other significant differences were found between the individuals.

6.3.4 Wild Versus Captive

As previously stated their behaviour of wild giraffe is well documented. Figures 6.7a-d show a comparison between activity budgets of wild giraffe and the activity budgets obtained for this study in captive giraffe, both diurnally and nocturnally. In all three captive individuals higher levels of standing were observed that was found in wild giraffe, particularly in enclosure 1 for the male, however, nocturnally although standing levels in the male were similar to those observed in the wild, the females spent less time standing than their wild counterparts did at night.

The amount of time the captive giraffes spent in locomotion was similar to the wild in all enclosures for the male and enclosure 2 for the females. In enclosure 1 and 3 however, both females exhibited locomotion at higher levels than their wild counterparts. The amount of time spent in locomotion for all captive animals nocturnally was similar to the levels observed in the wild.

Diurnally, it can also be seen that the females spent relatively similar amounts of time ruminating to the wild, but the male on the other hand ruminated far less in enclosure 1 and 2, but very similar in enclosure 3. Nocturnally all captive individuals proved to be ruminating for less than the wild. So, examining the overall budgets of the wild and captive giraffes, it can be seen that their budgets were very

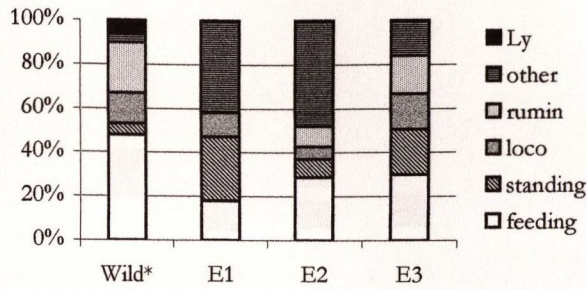


Fig 6.7a: Graph showing the differences in diurnal activity budgets between wild and captive male giraffes

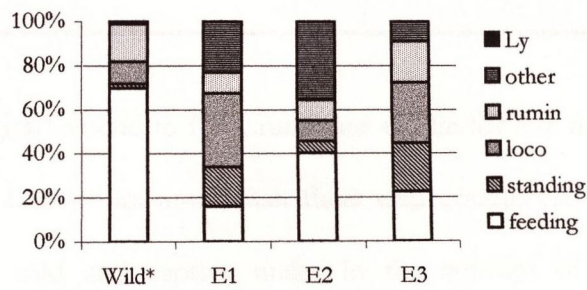


Fig 6.7b: Graph showing the differences in diurnal activity budgets between wild and captive female giraffes for the F1 female

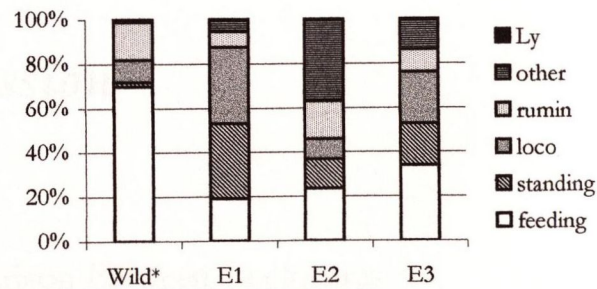


Fig 6.7c: Graph showing the differences in diurnal activity budgets between wild and captive female giraffes for the F2 female

* Wild data taken from (Pellow 1984a) where wild levels were shown in stack charts similar to these and estimated values from the graphs were used, E1=Enclosure 1, E2= Enclosure 2; E3 = Enclosure 3

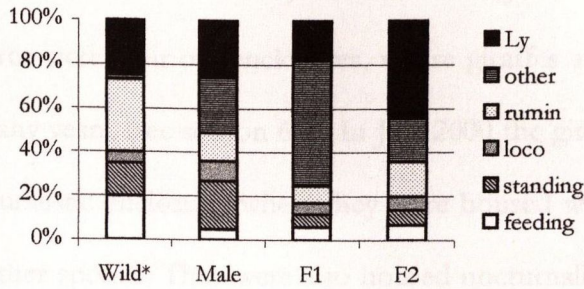


Fig 6.7d: Graph showing the differences between nocturnal activity budgets between wild and captive giraffe

F1 =Female F1; F2 =Female F2

different. Captive giraffes tend to feed, ruminate and lie for less time and stand and engage in “other” behaviours more than their wild counterparts. No difference occurred between wild and captive males in the amount of time they spent locomoting, however, both females spent greater time in locomotion than their wild counterparts.

6.4 Discussion

6.4.2 A Comparison Between Enclosures

Unlike the tapirs, giraffes did not have 24 hour access to the same enclosure all year round. Which paddock the giraffes were housed in diurnally was largely dependant on the weather. For example, during the winter in extremely harsh weather the giraffes remained in their inside enclosure where they were also housed nocturnally. However, during the summer in finer weather the giraffes were allowed

out into their outside paddock for the day and then brought inside for the night. These two enclosures were their old enclosures, where giraffes at Dublin zoo had been housed for many years, (see section 6.2). In July 2000 the giraffes were moved to a new more naturalistic enclosure, where they were housed with an extra three giraffes and with other species. They were also housed nocturnally in a new inside enclosure however, nocturnal data was not collected in this enclosure. This study examined the difference in behaviour of the same three individuals in the three enclosures mentioned above, and also looked at their nocturnal activities. Diurnally, all individuals demonstrated differences in their behaviour when housed in each enclosure.

Since enclosure 1 provided the giraffes with a bulk feed only, and enclosure 3 provided them with an opportunity to graze only, but enclosure 2 provided the giraffes with both browsing and grazing opportunities, it would be expected that their outside old enclosure would have elicited the highest level of feeding and foraging behaviours in all individuals. A difference in feeding and foraging levels in different enclosures was found between in females only. The F1 female did exhibit this as expected with feeding and foraging levels being significantly higher in enclosure 2. Although the F2 female also had significantly higher levels of foraging in the old outside enclosure, it was in the African Plains where grazing opportunities only were available, where she demonstrated the highest levels of feeding. In fact no difference was observed between the inside and outside enclosure in the F2 female. One possible explanation for this could be due to the dominance hierarchy. Browse was usually provided to the giraffes in enclosure 2 in the mornings, however, it usually consisted of two browse piles. It was observed that when either the male or the F1 female was at the browse piles, although no aggression was observed, the F2 female was often reluctant to approach.

Dominance hierarchy has been documented in the wild between females, and a cow will often yield its feeding place at the approach of another (Pellew 1984a). Enclosure 2 had less grass in the paddock than in the African Plains (enclosure 3), so in the African Plains the F2 female was able to increase her feeding levels through extra grazing and hence, exhibit feeding more in enclosure 3 than the other 2 enclosures. Usually in the wild the male will feed for less time than the females (Pellew 1984b), however, these captive giraffe showed no difference in their feeding levels between the individuals in any enclosure examined. In the wild the male giraffe will often spend his time moving from herd to herd in search of reproductively ripe females (Pellew 1984a), this accounts for the lower feeding observed in wild males compared in to females. In captivity the male no longer needed to concern himself with this behaviour as the females were already there for him and no other herds were available, this probably accounts for the lack of difference occurring between the individuals' feeding rates in captivity. There was also no difference between the individuals for foraging behaviour in any enclosure except for enclosure 2 where the F2 female spent significantly more time foraging than the male. The lack of difference between the individuals in foraging levels may be explained by the same reasoning above. The difference observed between the male and the F2 female may be explained due the hierarchy described above. In the absence of high levels of feeding, the F2 female increased her time spent foraging for food.

The highest levels of locomotion might be expected in the enclosure that had the largest area, in this instance, enclosure 3. However, all individuals showed no difference in locomotion levels between the enclosure with the smallest area, enclosure 1 and the largest enclosure, enclosure 3, with both these enclosures having greater levels than enclosure 2. Despite there being no difference in the

locomotion levels between enclosure 1 and 3, the locomotory types were indeed different. Enclosure 1 was an extremely small area and so locomotion in this enclosure was mainly circular pacing which perhaps could have been recorded as stereotypic locomotion. It is interesting to note that the pacing levels were performed at the same levels of "normal" locomotion when the giraffes were provided with adequate space. The individuals showed no signs of stereotypic locomotion in enclosure 3 hence, if we examine locomotion levels as "normal" locomotion, then it can be said that the individuals did behave as expected. Differences between the individuals in locomotory levels were found in enclosures 1 and 3 only, with the male spending less time in locomotion than both females. Other behavioural categories will need to be examined before a possible reason for these differences may be found.

The highest levels of standing would be expected in enclosure 1, since the area in their inside enclosure was very small and restricted the movement of the giraffes. However, it was only the F2 female which behaved as expected by showing significantly higher levels of standing in enclosure 1. The male and the F1 female also showed high levels of standing in enclosure 1 however, these levels were no different from the levels observed in enclosure 3. Again surprisingly we are seeing similarities between enclosure 1, which is the least optimal enclosure and enclosure 3, the most "naturalistic" enclosure. The only similarity between the enclosures was the absence of browse, suggesting that the presence or absence of browse causes significant effects on all behaviours and not just feeding. All behaviours must be examined before this concept can be further explored.

Only enclosure 2 caused individuals to differ in the time they spent standing, with the F2 female spending more time standing than the F1 female. As mentioned

above, the F2 female often had to wait to gain access to the browse piles, resulting in her spending more time standing than the F1 female.

Licking behaviour and tongue playing behaviour feature predominantly in captive giraffe studies (Koene & Visser 1997). Both these behaviours are often assumed to be negative behaviours and are commonly referred to as oral stereotypies, hence, we would expect to see the highest levels of these behaviours occurring in the least optimum enclosure i.e. enclosure 1, their inside enclosure. While tongue playing was performed at its highest in enclosure 1 for all three individuals, licking behaviour was performed at its highest in enclosure 2, their old outside enclosure. Both of these behaviours were performed least in all giraffes in the more "naturalistic" enclosure the African Plains. Since both behaviours were drastically reduced in the more "naturalistic" enclosure at first glance one might possibly agree with these behaviours being an indication of less than optimal conditions. However, if we examine these behaviours more closely perhaps a function for these behaviours may be presented.

Licking behaviour was at its highest in enclosure 2, not enclosure 1 which can be considered the enclosure with the least optimal conditions and would be expected to see higher levels of stereotypic behaviours. Enclosure 2 was the only enclosure where the giraffes were provided with a batch of browse in the morning. If licking behaviour does have a function, and its function is to provide the giraffes with oral stimulation, then perhaps feeding from browse elicits an internal desire for this stimulation. In the absence of browse this desire may not be elicited hence, high levels of this behaviour were observed in enclosure 2 only. Tongue playing on the other hand does show signs of occurring in conditions where other opportunities may be lacking. The observation that this behaviour became rarer in all individuals as the conditions of the enclosure improved, provides further evidence of this

behaviour being somewhat negative. In all enclosures, the male performed tongue playing behaviour significantly more than both females. As said previously, males in the wild spend large proportions of their activity budgets feeding, and much of the rest in search of reproductive females. In the absence of having to perform either behaviour in captivity, the male had additional time in his budget, so he increased this behaviour to avail of this additional time, whereas the females increased their locomotion levels to avail of this time.

6.4.2 It was only the male who altered his sexual behaviour in different enclosures. As expected he demonstrated the lowest levels of sexual behaviour in enclosure 1. In this enclosure the male was separated from the females. He could still perform sexual behaviours in the inside enclosure by leaning over the barrier and sniffing and flehmen the females, if they were near the barrier, however since he was separated from them, the occurrence was less frequent than in the other two enclosures. In all enclosures the male spent more time engaged in sexual activity than either female. As seen in the tapirs (chapter 5), the male giraffe was much more the pursuer of sexual advances and had sexual activity recorded where the females did not. An example is flehmen, where the male tastes the females' urine for reproductive receptivity; in this instance it is only the male behaviour that was recorded as sexual not the female's.

Finally, sparring behaviour was observed the most frequently in enclosure 2 for the male and the F2 female. The individuals were separated in enclosure 1 so it is not surprising low levels of sparring occurred in this enclosure. Bouts of sparring were mostly initiated by the male towards the F2 female. Enclosure 2 was a lot smaller than enclosure 3, and higher levels of sparring were probably observed in enclosure 2 because the F2 female had more room to flee attacks in the African Plains, while she had to stay and engage in these matches in their outside old

enclosure. Sparring is a behaviour which occurs in the wild only in the males, to establish dominance hierarchy (Coe 1967). It is therefore very unusual for this behaviour to occur in a female. Since the male had no other males with which to display dominance perhaps in the wild there may be some other underlying motivation as well as establishing dominance, to carry out sparring or necking behaviour.

6.4.2 A Comparison Between Wild and Captive Giraffe

Figures 6.7a-d showed a comparison between the activity budgets of wild and captive giraffe. As a result of this examination, it was found that giraffes in captivity do behave differently from their wild counterparts. This study examined captive giraffe in three very different enclosures, ranging from what would be considered a less than optimal enclosure (enclosure 1), a slightly better enclosure but still less than optimal (enclosure 2) and finally, a more "naturalistic" enclosure and the most optimal enclosure out of the three (enclosure 3).

Wild data were compared with data from each enclosure. It would be expected that the more naturalistic the enclosure the more the giraffes behavioural budgets should approach wild type behaviours. However, table 6.5 shows that in fact this was not the case. Table 6.5 simply allocates a "W" to the enclosure which is most similar to the wild for a given behaviour, hence the greater the number of "W"s, the more behaviours which are similar to the wild. In other words a "W" is allocated to the enclosure which is closest to the wild percentage time spent in any given behaviour.

Table 6.5 showed that in the male did in fact behave as expected and demonstrated enclosure 3 as resembling the wild more than the other two

	Male			F1 Female			F2 Female		
	E1	E2	E3	E1	E2	E3	E1	E2	E3
Feeding		W	W		W				W
Standing		W			W			W	
Locomotion			W		W			W	
Rumination			W			W		W	
Other			W			W	W		
Lying									

Table 6.5: Table showing the enclosures which are most similar to the wild levels for each behaviour

enclosures. In both females it was enclosure 2 which most closely resembled the wild, despite enclosure 3 being the most “naturalistic” enclosure.

All three individuals as expected showed enclosure 1 to be the least like the wild. This was expected as enclosure 1 had no browse available, the individuals were separated and they were housed in very small restricted areas. It is surprising that the females behaved more like their wild counterparts in enclosure 2 than enclosure 3 as enclosure 2 was far smaller in area and had fewer individuals. Veasey *et al.* 1996, demonstrated that rumination was positively correlated with enclosure size. The male and the F1 female also demonstrated this however, the F2 female did not. Furthermore, Veasey *et al.* (1996) found that locomotion was positively correlated with enclosure size and that stereotypic locomotion did not occur more in smaller enclosures, however, this study found that in enclosure 1, the smallest enclosure, locomotion was at the highest and that most of this locomotion could be attributed to locomotor stereotypies.

The giraffes did not receive browse in enclosure 3 in the mornings, but they did in enclosure 2. Perhaps then it is the presence or absence of browse which is the defining factor to encourage more wild type behaviour levels, and not enclosure size

or group composition. Furthermore the occurrence of browse may have significant effects on other behaviours as well as feeding, (see chapter 8).

All individuals in all enclosures demonstrated significantly higher levels of “other” behaviours than their wild counterparts. Included in “other” behaviours for this analysis were licking, tongue playing, sexual behaviour, sparring, interactive behaviours, drinking, scratching and a few other rare behaviours not previously described. It was shown in section 6.4.1 that all giraffes spent a large proportion of time licking and engaged in tongue playing behaviour as well as other behaviours mentioned above.

In captivity, where searching for food or feeding take up little time, they were left with available time in their budget; hence in captivity behaviours are increased to higher frequencies or new behaviours are created that may not be observed in the wild. This concept will be discussed further in depth in the discussion chapter, chapter 11.

6.4.3 Conclusion

A study was conducted on the diurnal and nocturnal activity budgets of captive giraffe. The diurnal study examined their behaviour over three very different enclosures ranging from very “unnatural” to fairly “natural”. Comparisons with the behaviour of wild giraffes were also made.

The activity budgets of captive giraffes were extremely variable. Unlike the tapirs (chapter 5), they varied not only between individuals and sexes, but also between enclosures. However, like the tapirs, captive giraffe behaved differently from their wild counterparts. Furthermore, they did not increase their behaviours to wild type levels despite having one enclosure rated “naturalistic”. In fact the most

“naturalistic” enclosure did not prove to have the closest behavioural pattern to that found in the wild.

Finally, it appears likely that the presence or absence of browse may have a large effect the behavioural budgets of captive giraffe - more so than either enclosure size or type, or group composition.

*Eliciting Wildtype
Behaviour*

Chapter Seven

FEEDING EXPERIMENT: TAPIRS

7.1 Introduction

Eliciting Wildtype Behaviour

Chapter Seven

FEEDING EXPERIMENT: TAPIRS

7.1 Introduction

Wild type behaviour is often used as a criterion when examining captive animals' behaviour (see chapter 1 section 1.9). It is often used to benchmark the welfare of these animals and frequently, enrichment is aimed at increasing behaviours to the same level as observed in the wild. However, a problem arises when the conditions in which the animals live are different from the wild, eg. captivity. Therefore, I believe the aim of enrichment should not necessarily try and simulate wild type behaviour patterns, but rather, to encourage and enhance behaviours which have been previously demonstrated as important to the animals, in a captive environment.

In order to be able to examine the needs of captive animals (see chapter 1 section 1.10), the actual properties of the behaviours must be assessed. For example, some behaviours expressed in an animal's repertoire may be expressed more frequently than others. At initial examination, these behaviours may be thought of as more important. However, Dawkins(1983), showed that dust bathing in hens is in fact an extremely important behaviour to the hens despite it not being a particularly frequent behaviour occurring in their repertoire. Dawkins then went on to explain these behaviours as "inelastic" and "elastic" behaviours, and that it is not the most

frequently occurring behaviour that is important but rather, how elastic or inelastic a behaviour is (see chapter 1, section 1.11).

Chapter five examined the activity budgets of two groups of captive tapirs, Dublin and Fota. Although no quantitative data have been obtained on the activity budgets of wild tapirs, results indicated that captive individuals are less active than their wild counterparts, and that it is reasonable to assume that they spend less time feeding in captivity than in the wild.

The aim of this experiment was two-fold; firstly to attempt to increase their feeding related behaviours and hence, activity levels, and secondly, to examine the properties of the behaviours being expressed by these animals.

This study gave the tapirs the opportunity to converge with wild type behaviour by providing them with an opportunity to increase their activity levels. Feeding experiments were chosen, as feeding is the main behaviour expressed by most herbivores in the wild. By providing them with this opportunity to increase feeding levels, the properties of the behaviours could then be examined. In other words, if some behaviours do increase, which behaviours are sacrificed, reduced or eliminated, and which behaviours remain inelastic and remain at the same level at the expense of other behaviours?

This experiment altered the presentation of food only, it did not change the amount of food or the time at which they were normally fed.

7.2 Method

Both Dublin and Fota individuals were fed in the morning at approximately 10.00 hours. For the Dublin individuals this was their only feeding time. However, Fota individuals were also fed in the afternoons at about 16.00 hours.

Feeding experiments took place for both zoos during the summer season and when no juvenile was present. Under the normal husbandry routine and during non-experimental/baseline days, both groups were fed from a single trough, which was usually located in their indoor enclosure, however, in good weather this trough was located outdoors.

In this experiment the tapirs were provided with four feeding stations around their outside enclosure, in the form of buckets dug into the ground. On experimental days the individuals were fed from these stations. They received the same amount of food and at the usual feeding time on experimental days as non-experimental days. The difference between experimental and non-experimental lay in the presentation of food on experimental days. On these days, the tapirs' food was separated and placed in three out of the four feeding stations. Each station had approximately the same amount and type of food in it. Only three stations out of four were supplied with food on experimental days, so that the tapirs did not know which stations contained food, furthermore, they did not receive a reward at each station, hence encouraging them to explore all stations.

This experiment alternated experimental days with non-experimental over a two week period. As with the activity budgets, 5 replicates of each observational and experimental conditions for the feeding experiment were made. On both experimental and nonexperimental days were made.

Data were collected using the same sampling method as for the tapirs' activity budgets (see section 5.2). Data were collected in two sessions, morning (10.00-13.00) and afternoon (14.00-17.00).

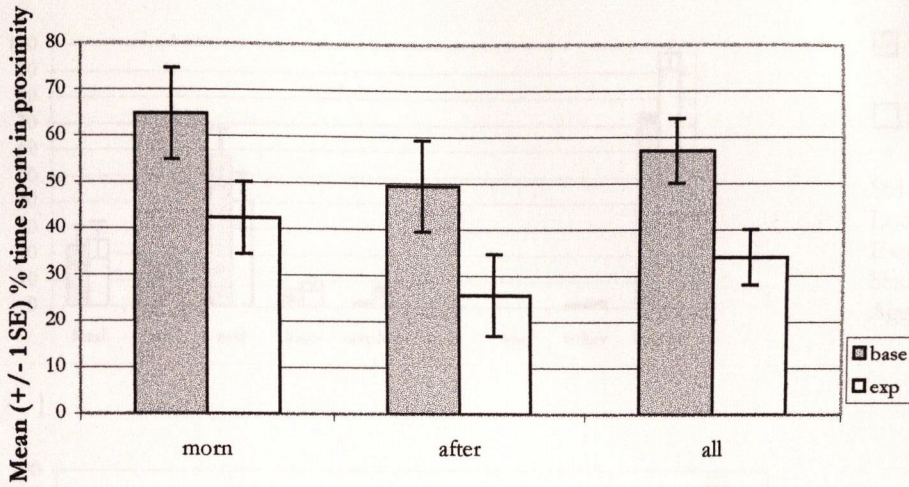
Both Dublin and Fota had similar conditions for this experiment apart from Fota having an additional feed in the afternoon, which under experimental days was presented from the feeding stations as in the morning feed.

7.3 Results

7.3.1 Dublin Zoo

Examining the entire day and comparing the experimental with non-experimental days, no statistically significant differences were observed for either individual for any category recorded except proximity. When examining the entire day the individuals spent significantly less time in each others proximity during experimental conditions compared to non-experimental ($U=58$; $N=5,5$; $P=0.003$)(see fig 7.1). However, examining the data more closely by separating the morning and afternoon, differences in behavioural categories and area usage were observed.

Figure 7.2a and 7.2b show the difference in the amount of time both individuals spent in each activity when comparing the baseline (non-experimental) and experimental conditions, for the morning period of observation. The female showed a significant increase in locomotory and exploratory behaviour (locomotory: $U=54.5$, $N=5,5$; $P=0.001$; explore: $U=52.5$; $N=5,5$; $P=0.02$).

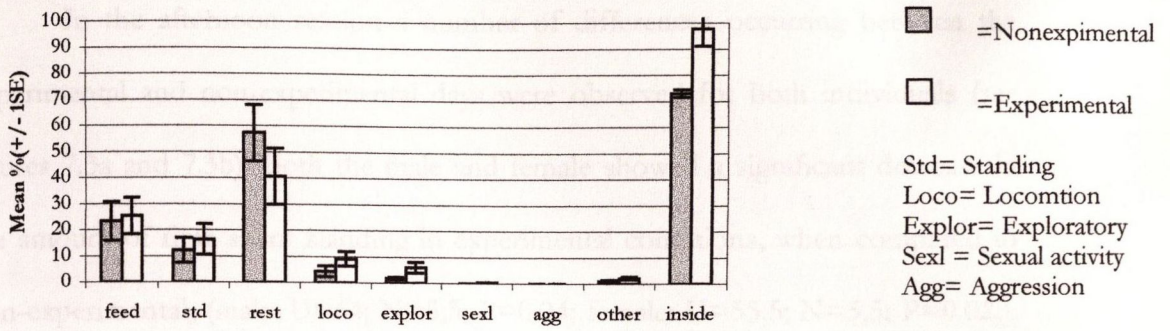


g 7.1: Graph showing the difference between the experimental and non-experimental conditions in proximity for the Dublin individuals **Fi**

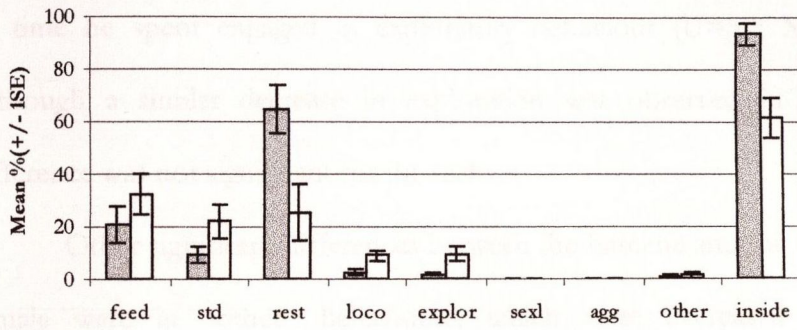
Additionally, the female showed a significant decrease in resting behaviour under experimental conditions ($U=59$; $N=5,5$; $P=0.03$). The female also spent a greater proportion of her time outdoors in the morning during experimental days compared to non-experimental days ($U=57$; $N=5,5$; $P=0.001$).

The male showed a similar pattern to the female by increasing locomotory and exploratory behaviours and showing a decrease in resting during experimental mornings, however, these differences were not found to be significant. Unlike the female, the male showed a decrease in the amount of time spent outdoors during experimental conditions ($U=55.5$; $N=5,5$; $P=0.001$).

In the morning session the individuals spent in less time in proximity to one another in experimental conditions compared to non-experimental days ($U=53$; $N=5,5$; $P=0.04$).

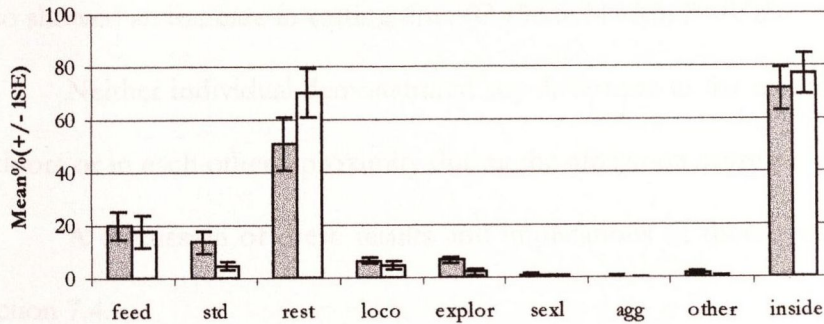


(a)

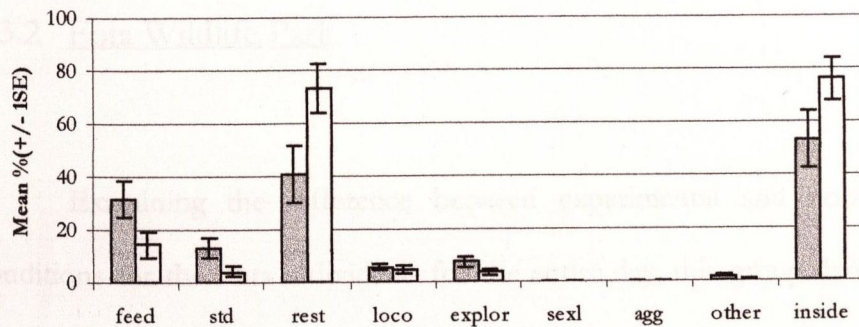


(b)

Fig 7.2a&b: Graphs showing the difference between experimental and non-experimental conditions during the morning session, for the Dublin male (a) and the female (b)



(a)



(b)

Fig 7.3a&b: Graph showing the difference between experimental and non-experimental conditions during the afternoon session, for the Dublin male (a) and the female (b)

In the afternoon session a number of differences occurring between the experimental and non-experimental days were observed for both individuals (see figures 7.3a and 7.3b). Both the male and female showed a significant decrease in the amount of time spent standing in experimental conditions, when compared to non-experimental, (male: $U=64$; $N=5,5$; $P=0.04$; female: $U=55.5$; $N=5,5$; $P=0.02$). In addition to standing, the male also showed a significant decrease in the amount of time he spent engaged in exploratory behaviour ($U=57$; $N=5,5$; $P=0.02$). Although a similar decrease in exploration was observed in the female, this difference was not significant for the male.

Other significant differences between the baseline and the experiment in the female were in "other" behaviours, which were decreased in experimental conditions and feeding, which was also decreased (other: $U=59$; $N=5,5$; $P=0.05$; feeding: $U=65$, $N=5,5$; $P=0.05$). In addition to the decreased behaviours the female also showed an increase in resting time ($U=58.5$; $N=5,5$; $P=0.02$).

Neither individual demonstrated any difference in the amount of time spent indoors or in each others' proximity during the afternoon session.

A discussion of these results and implications of them will be discussed in section 7.4.

7.3.2 Fota Wildlife Park

Examining the difference between experimental and non-experimental conditions for the Fota individuals for the entire day, this group demonstrated no difference in any category recorded. Indeed, no differences were observed for either

individual in either the morning or afternoon session, when these were analysed separately.

When however, the actual hours of feeding were considered some differences were observed. Fota individuals received two feeds per day, so the hours of feeding were 10.00-11.00 hours in the morning session and 16.00-17.00 hours in the afternoon.

Figures 7.4a,b, and c show the difference between the conditions for these hours. During the morning feeding hour during experimental conditions both the male and the female demonstrated an increase in exploratory behaviour (male: $U=0$; $N=5,5$; $P=0.008$; female: $U=0$; $N=5,5$; $P=0.008$) and a decrease in the amount of time they spent indoors and in proximity to one another (*indoors*: male: $U=3$; $N=5,5$; $P=0.045$; female: $U=2$; $N=5,5$; $P=0.027$; *proximity*: male: $U=1$; $N=5,5$; $P=0.015$; female: $U=1$; $N=5,5$; $P=0.015$). Additionally, the female increased the amount of time she spent feeding during the feeding hour in experimental conditions.

In the afternoon feeding hour i.e. 16.00-17.00 hours, the male exhibited an increase in feeding and exploratory behaviour during experimental conditions (feeding: $U=1$; $N=5,5$; $P=0.016$; exploratory: $U=0$; $N=5,5$; $P=0.009$). However, in addition he demonstrated a significant decrease in the amount of time he spent resting during experimental days, for the afternoon feeding hour ($U=1$; $N=5,5$; $P=0.015$). The female on the other hand, exhibited no change in any category during the afternoon feeding hour when comparing experimental and non-experimental days.

During the rest of the afternoon session i.e. 14.00-16.00 hours, both individuals showed a decrease in the amount of time they spent feeding on experimental days (male: $U=24.5$; $N=5,5$; $P=0.03$; female: $U=20$; $N=5,5$; $P=0.015$).

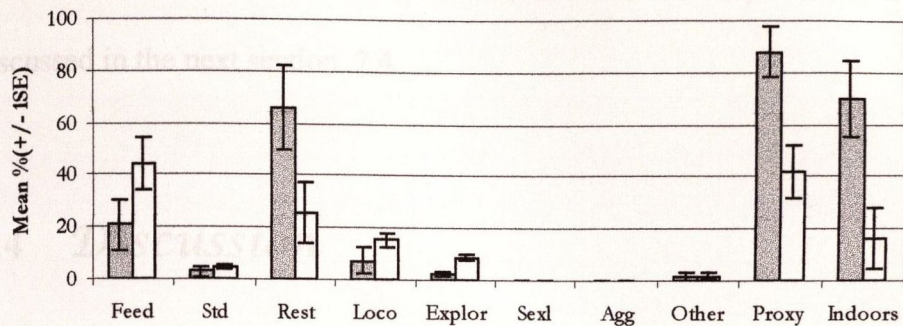


Fig 7.4a: Graph showing the difference between experimental and non-experimental conditions during the morning feeding hour i.e. 10-11am, for the Fota male

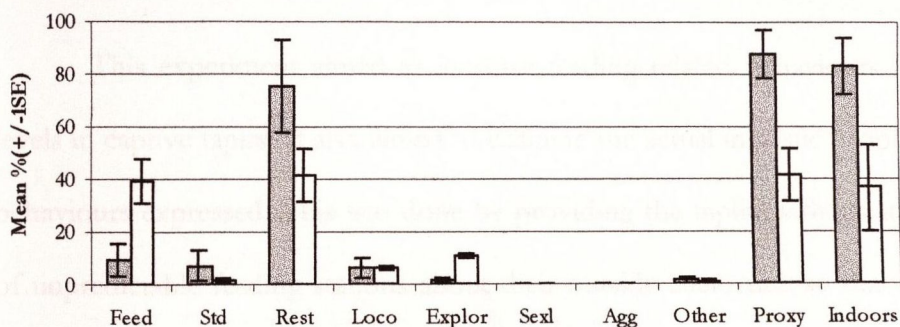


Fig 7.4b: Graph showing the difference between experimental and non-experimental conditions during the morning feeding hour, i.e.10-11am, for the Fota female

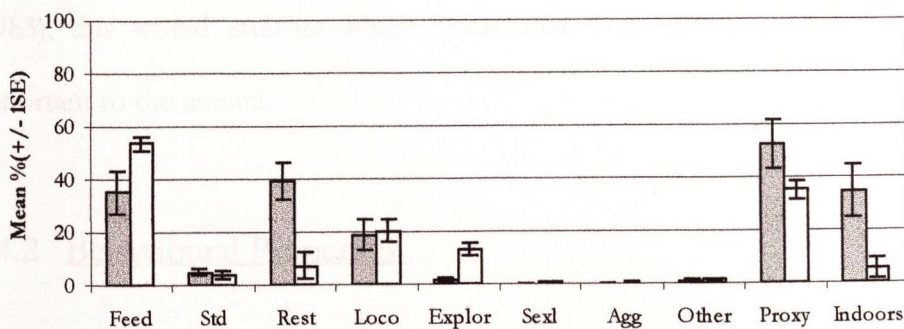


Fig 7.4c: Graph showing the difference between experimental and non-experimental conditions during the afternoon feeding hour, i.e. 4-5pm for the Fota male

■ = Non-exp □ = Exp

As with the Dublin results, these results and their implications will be discussed in the next section, 7.4.

7.4 *Discussion*

7.4.1 The Experiment

This experiment aimed to increase feeding related behaviours and activity levels in captive tapirs. It also aimed to examine the actual inelastic properties of the behaviours expressed. This was done by providing the tapirs with greater numbers of unpredictable feeding stations about their outside enclosure, so that the animals would have to spend more time searching for food. By increasing exploratory levels, other behaviours would have to be reduced. This would then inform us which behaviours the individuals were willing to sacrifice or reduce. According to Dawkins (1983), this would indicate which behaviours were more, and which were less important to the animal.

7.4.2 Behavioural Properties

The results of this experiment provide very interesting information on the behavioural properties of tapirs. Table 7.1 shows a summary of changes occurring between the behaviours for all individuals. From the table it can be seen that for the Dublin individuals, the afternoon changes are opposite to the morning changes in almost all categories except proximity and aggression. In other words where an

Table 7.1: Table Showing the direction of change from non-experimental to experimental in the morning and afternoon sessions for each individual. I= increase; D=decrease; _=no change; *= significant change

Behaviours	Dublin Male		Dublin Female		Fota Male		Fota Female	
	Morn	After	Morn	After	Morn	After	Morn	After
Feed	I	D	I	D*	I	D	I	D
Std	I	D*	I	D*	D	D	D	D
Rest	D	I	D*	I*	D	I	D	I
Loco	I	D	I*	D	I	D	I	D
Explor	I	D*	I*	D	I	I	I	I
Sexl	I	D	-	-	-	I	-	-
Agg	D	D	-	-	-	I	-	I
Other	I	D	I	D*	I	D	I	D
Proxy	D	D	D	D	D	D	D	D
Inside	D*	I	D*	I	D	D	D	D

increase is observed in the morning, there is a corresponding decrease in the afternoon for that category. However, a similar pattern is observed in the Fota individuals for feeding, resting, locomotory and “other” behaviours only.

In the Dublin group, when the experimental conditions were provided i.e. the morning, an increase can be seen for both individuals for feeding, standing, locomotory, exploratory, sexual and “other” behaviours. The increases in sexual behaviour and “other” behaviours are highly unlikely to be related to the feeding experiment. The actual amount of time spent in these activities is extremely small in the first instance and so any increase or decrease observed was very minimal. This may also be applied to any changes occurring in aggressive behaviour. However, the other categories, along with the decreases observed in resting, proximity and the amount of time spent indoors can be explained as a result of the experiment. Separating the food and providing it to them outdoors, encouraged the individuals to be more active in searching for food.

The fact that not all buckets were filled during the experiment meant that the tapirs did not know which stations contained food and so could not just go directly to them, they had to search. This accounts for the increases in locomotory, and exploratory behaviours. Although both exhibited an increase in feeding, this does not mean that they were eating more, as they were supplied with the same amount of food during experimental and non-experimental days, it merely means that during the experiment they spent more time feeding since they did not receive food in one bulk feed. In order to enable the individuals to spend more time engaged in these activities, other activities had to be reduced. In this instance it was resting behaviour which was reduced.

In the Fota group (when considering the feeding hours only), as in Dublin, an increase in the morning for feeding, locomotory and exploratory behaviour was observed, along with a decrease in resting. However, in the afternoon session, although an increase in resting behaviour was observed, so too was a further increase in exploratory behaviour. Similarly, a decrease in the amount of time spent indoors was observed in the morning and afternoon sessions for both individuals. Fota tapirs exhibited some changes in the afternoon which were also present in the morning, while Dublin did not show this pattern. This is because as stated earlier, Fota received two feeds daily and so had an opportunity to undergo experimental conditions twice daily.

The most interesting aspect of this study can be seen in figures 7.5a,b,c and d. These graphs show the difference between experimental and non-experimental conditions for each category for the entire day. Although the experiment altered when the behaviours were performed and for how long, the graphs show that the mean time spent in each activity for the entire day remained virtually the same as it was under normal husbandry regime. This suggests that while the activity budgets of

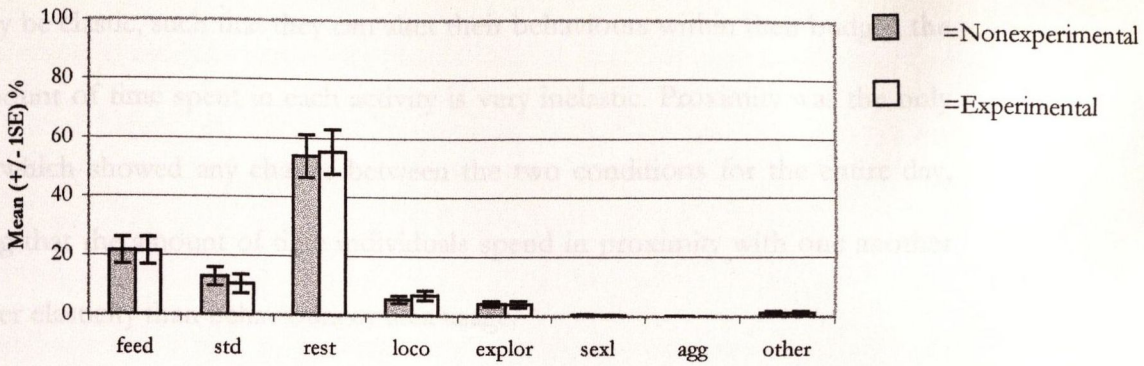


Fig. 7.5a: Graph showing the difference between experimental and non-experimental conditions, for the entire day, for the Dublin male.

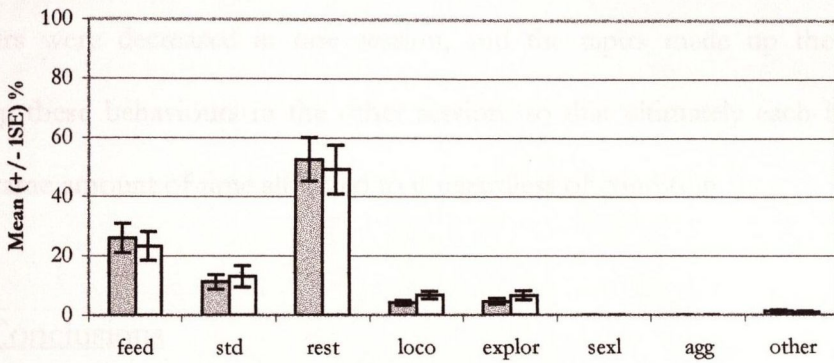


Fig. 7.5b: Graph showing the difference between experimental and non-experimental conditions, for the entire day for the Dublin female

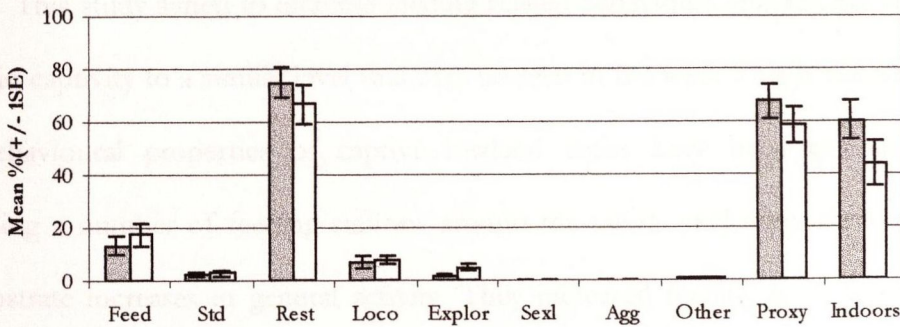


Fig 7.5c: Graph showing the difference between experimental and non-experimental conditions, for the entire day, for the Fota male

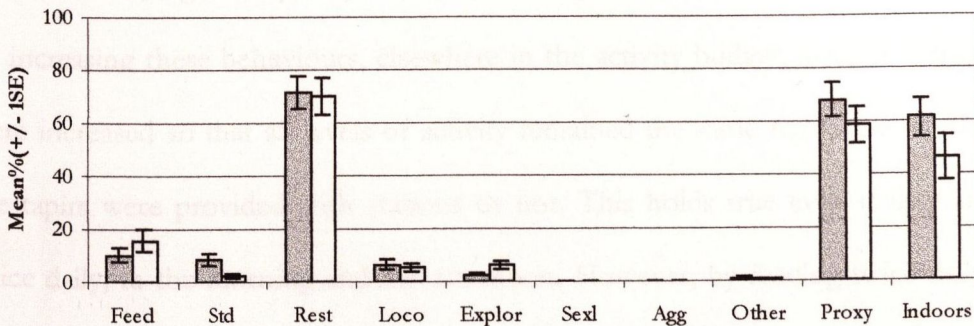


Fig 7.5d: Graph showing the difference between experimental and non-experimental conditions for the entire day for the Fota female

tapirs may be elastic, such that they can alter their behaviours within their budget, the actual amount of time spent in each activity is very inelastic. Proximity was the only category which showed any change between the two conditions for the entire day, suggesting that the amount of time individuals spend in proximity with one another had greater elasticity than behaviours or area usage.

This phenomenon was brought about by the tapirs reducing behaviours in one session to compensate exactly for their increase in the other session. Thus, some behaviours were decreased in one session, and the tapirs made up the time by increasing these behaviours in the other session, so that ultimately each behaviour had the same amount of time allocated to it regardless of condition.

7.4.3 Conclusions

This study aimed to increase feeding related behaviours and activity levels of tapirs in captivity to a similar level that may be seen in the wild. This is the first time the behavioural properties of captive lowland tapirs have been examined. By providing a number of feeding stations around the tapirs' enclosure, the tapirs did demonstrate increases in general activity. They increased feeding time, locomotory behaviour and exploratory behaviour. However, despite this, these increases were short lived, and generally only occurred for the hour of feeding time. Furthermore, by increasing these behaviours, elsewhere in the activity budget, inactive behaviours were increased so that all levels of activity remained the same regardless of whether the tapirs were provided with stations or not. This holds true even if they are fed twice daily, in the morning and the afternoon. However, by feeding twice daily two bouts of high activity occurred instead of just one in the morning.

These results show that the tapirs will briefly increase their activity levels if made do so, but will still ensure the same over all level of resting occurs. This suggests that all behaviours exhibited in the tapirs' budget are relatively inelastic and may be regarded as having equal importance, despite the amount of time allocated to each activity being different.

In order to confirm whether all behaviours are of equal importance a further test could have been conducted. Both groups had 24-hour access to their outside paddock. By providing this experiment to them with a limited time budget in which to perform the behaviours, we should see the less important behaviours being greatly reduced or eliminated. This means that if the tapirs were locked in at night, by encouraging more resting behaviour nocturnally, they would only have a limited time in which to perform certain activities, hence not so important behaviours would give way for important behaviours. However, in the interest of the tapirs' welfare this experiment was not allowed to be conducted. Locking the tapirs in at night would leave no access for either individual to get away from fighting or aggressive encounters etc.

Another way to examine the needs of the tapirs or the importance of behaviours or commodities to the animals, is by preference testing, see chapter 9 and 10.

Chapter Eight

FEEDING EXPERIMENT:

GIRAFFES

8.1 *Introduction*

The activity budgets of the giraffes indicated that in captivity they were not feeding for a similar amount of time as their wild counterparts (section 6.3.4). This study aimed to provide the giraffes with an opportunity to increase their feeding levels to a similar level to that observed in the wild. Hence, by doing so, to examine if wild type behavioural patterns can be elicited in captive giraffe.

8.2 *Method*

Usually giraffes are provided with one batch of browse given to them in the morning, which is often defoliated by lunchtime. This experiment provided the giraffes with a continuous supply of browse throughout the day, ensuring that the giraffes had fresh browse piles available for the entire day. Browse was tied to their browse poles and gates surrounding the enclosure. Their behaviour was recorded between the hours of 10.00-13.00 hours (morning session) and 14.00-17.00 hours

(afternoon session), using the same sampling method, ethogram of behaviours and check sheets, as the activity budgets (see section 6.2).

This experiment was carried out over two weeks alternating non-experimental/baseline days with experimental days. On baseline days, the giraffes' normal husbandry regime was adhered to and they were provided with browse in the mornings only. On experimental days, the giraffes were provided with a continuous plentiful supply of fresh browse throughout the day.

The experimental procedure generated 5 replicates of baseline and experimental recordings for each observational hour.

8.3 Results

8.3.1 Activity Budgets

Examining Individuals

Figures 8.1a,b and c show the difference between behavioural categories during the baseline and experiment for each individual for the morning observation period i.e. 10am to 1pm.

All three individuals, the male, F1 female and F2 female, demonstrated a significant decrease in the amount of time they spent in licking behaviour in experimental conditions compared to the baseline (*male*: $U=18$, $N=5,5$, $P=0.04$; *F1*: $U=22.5$, $N=5,5$, $P=0.05$; *F2*: $U=12$, $N=5,5$, $P=0.007$).

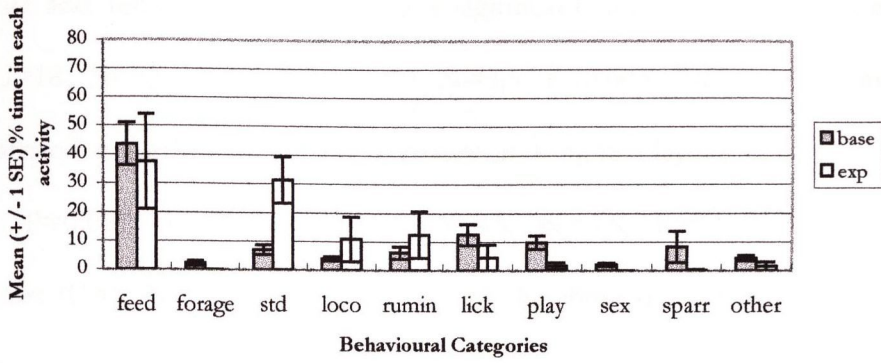


Fig 8.1a: Graph showing the difference between baseline and experiment results for the male during the morning observation period.

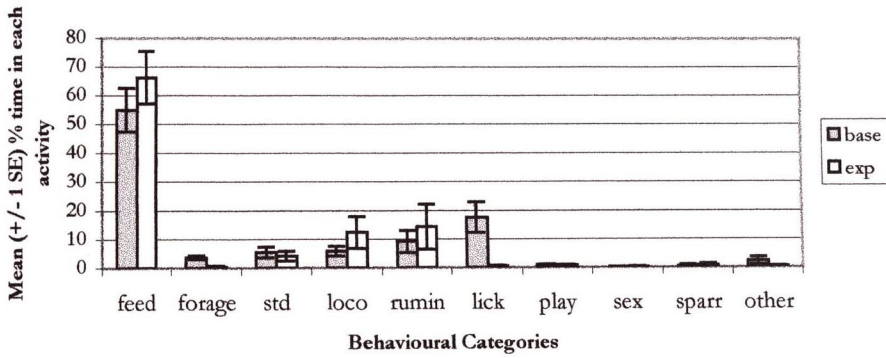


Fig 8.1b: Graph showing the difference between baseline and experiment results for the female F1 during the morning observation period.

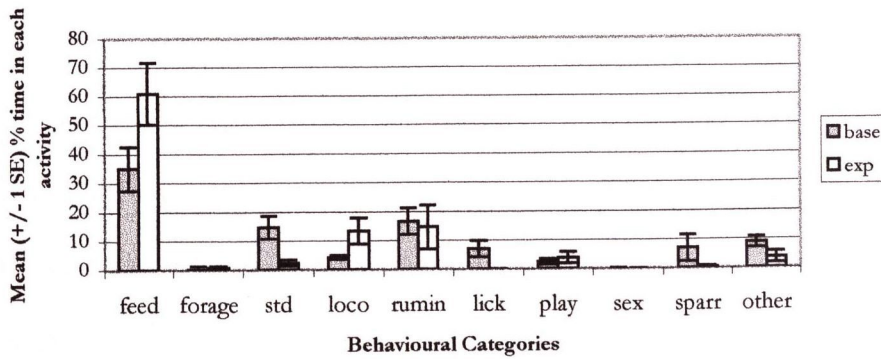


Fig 8.1c: Graph showing the difference between baseline and experiment results for the female F2 during the morning observation period.

The male and female F1, also showed a significant decrease in foraging activity (*male*: $U=18$, $N=5,5$, $P=0.02$; *F1*: $U=9$, $N=5,5$, $P=0.005$). In addition, the male demonstrated a further significant decrease in tongue playing behaviour ($U=9$, $N=5,5$, $P=0.02$), sexual behaviour ($U=15.5$, $N=5,5$, $P=0.004$) and "other" behaviours ($U=9$, $N=5,5$, $P=0.02$). Conversely, he showed a significant increase in the amount of time spent standing during experimental conditions ($U=15.5$, $N=5,5$, $P=0.05$).

The female F1 showed no other significant differences in any of the behavioural categories between the baseline and experiment. However, female F2 in contrast to the male, showed a significant decrease in the amount of time spent standing ($U=19$, $N=5,5$, $P=0.05$).

None of the individuals showed a significant increase in the amount of time spent feeding, comparing the baseline and experimental conditions. This is not surprising, since normal husbandry also provided browse in the morning period.

Figures 8.2a, 8.2b and 8.2c show the difference between conditions as observed during the afternoon session. The male demonstrated no significant difference in any behavioural activity recorded.

However, as in the morning period, both females demonstrated a significant decrease in foraging behaviour (*F1*: $U=7.5$, $N=5,5$, $P=0.005$; *F2*: $U=2.5$, $N=5,5$, $P=0.001$) and licking behaviour (*F1*: $U=6$, $N=5,5$, $P=0.003$; *F2*: $U=8$, $N=5,5$, $P=0.004$), in the experimental conditions.

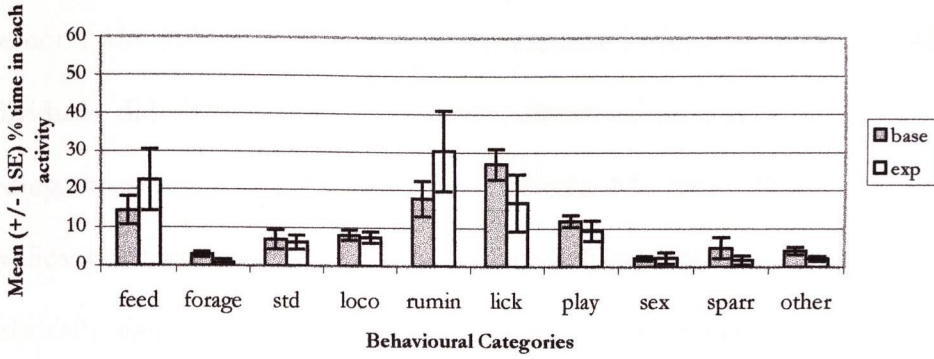


Fig 8.2a: Graph showing the difference between baseline and experiment results for the male during the afternoon observation period.

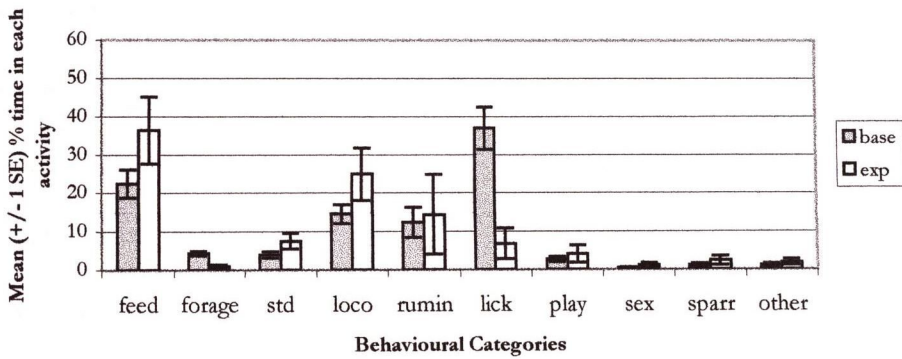


Fig 8.2b: Graph showing the difference between baseline and experiment results for the female F1 during the afternoon observation period.

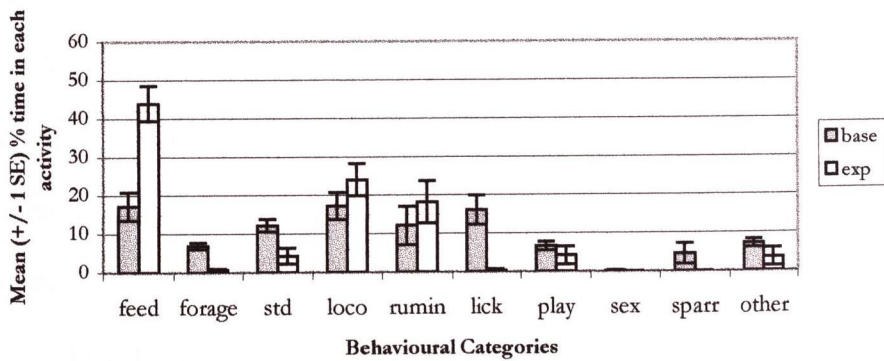


Fig 8.2c: Graph showing the difference between baseline and experiment results for the female F2 during the afternoon observation period.

It would be expected that due to the new availability of fresh browse in the afternoon, the individuals would show an increase in feeding behaviour. All three individuals did show an increase in the amount of time they spent engaged in feeding, however, for the male and the female F1, these differences were not significant, although they were for the F2 female ($U=6.5, N=5,5, P=0.003$). No other statistically significant differences were observed in any other behavioural category between the conditions.

Combining the two sessions, the overall diurnal difference can be seen in figures 8.3 a-c. All three showed a significant decrease in the amount of time spent foraging (male: $U=82, N=5,5, P=0.005$; F1: $U=35, N=5,5, P=0.001$; F2: $U=55.5, N=5,5, P=0.0005$) and an overall significant decrease in licking (male: $U=101, N=5,5, P=0.03$; F1: $U=63.5, N=5,5, P=0.002$; F2: $U=43, N=5,5, P=0.001$), when browse was made available to them all day. Both the male and female F2 showed a further significant decrease in "other" behaviours (male: $U=94, N=5,5, P=0.02$; F2: $U=98, N=5,5, P=0.03$). The male also showed a significant decrease in tongue playing behaviour ($U=100, N=5,5, P=0.03$) and sexual behaviour ($U=96, N=5,5, P=0.02$), under experimental conditions. The F2 female showed a significant decrease in standing behaviour ($U=61.5, N=5,5, P=0.003$) and an increase in locomotory behaviour ($U=103, N=5,5, P=0.0001$) in the presence of additional browse.

Due to the extra provision of browse it was expected to see an increase in feeding behaviour across the individuals. Despite all three demonstrating some increase in feeding, this increase was significant only in the female F2 ($U=72, N=5,5, P=0.003$). Section 6.3.1 showed that the F2 female fed for a significantly lower proportion of time than the F1 female. The increase that can be seen in the F2 female in this experiment, did not rise to the same level as wild type behaviour,

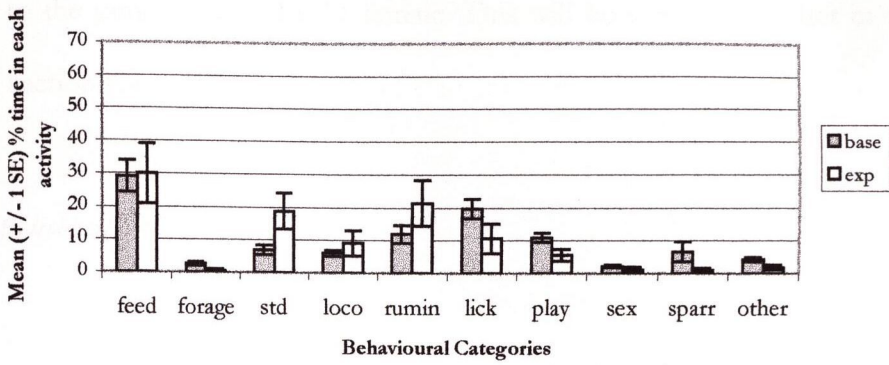


Fig 8.3a: Graph showing the difference between baseline and experiment results for the male over the entire observation period.

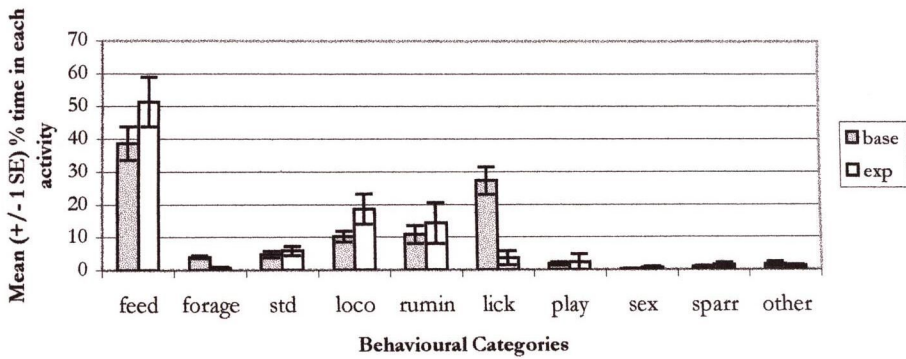


Fig 8.3b: Graph showing the difference between baseline and experiment results for the female F1 over the entire observation period.

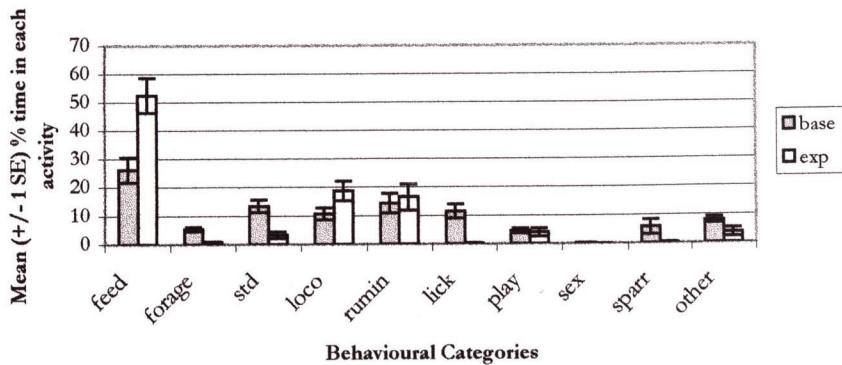


Fig 8.3c: Graph showing the difference between baseline and experiment results for the female F2 over the entire observation period.

but raised to the same level as the F1 female. This will be discussed further in the discussion section 8.4.

Comparing Individuals

Finally, comparing the difference between the individuals under experimental conditions for the entire day, it can be seen from figure 8.4, that there was no significant difference in any behavioural category between the individuals except for feeding and standing. The male spent a significantly lower proportion of time feeding ($\chi^2 = 10.786$; $df = 2$; $P=0.005$), post hoc analysis shows that this difference is between the male and both females (Post hoc analysis: critical value= 16.14; critical differences: Male -F1=16.84; Male -F2=24.44; N=5,5,5; significant at $P<0.05$).

Conversely the male spent a greater proportion of time standing in the experimental condition compared to both females ($\chi^2 = 12.218$; $df = 2$; $P=0.001$), (Post hoc analysis: critical value= 16.44; critical difference: Male-F1=20.83; Male-F2= 16.91; N=5,5,5; significant at $P<0.05$). No difference in either feeding or standing was observed between the females.

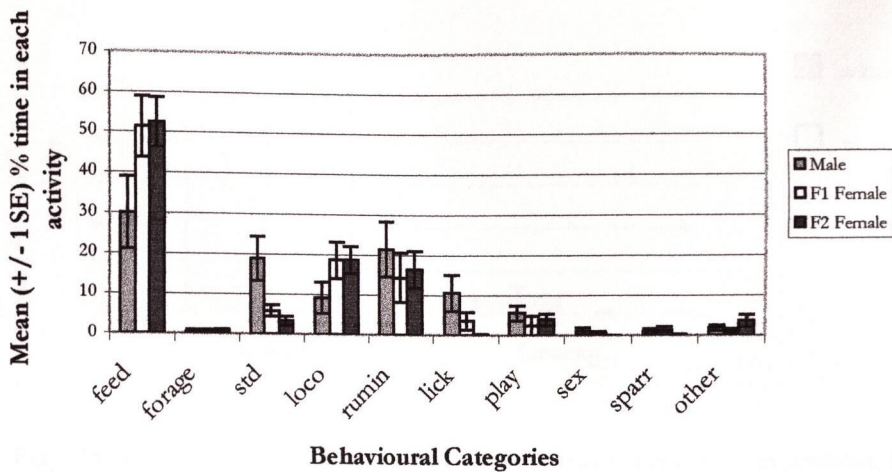


Fig 8.4: Graph showing the difference between individuals for the entire observation period under experimental conditions.

8.3.2 Feeding

Examining Individuals

As seen in the previous section it was only the F2 female which significantly changed her percentage time spent feeding. Feeding was recorded as either browsing or grazing. This section examines whether any differences occurred within the type of feeding carried out, despite the male and F1 female not altering the total time they spent feeding. Figures 8.5a, b and c show the difference in browsing and grazing between the baseline and the experiment for each individual.

Examining the entire day, it could be seen that the male browsed more and grazed less under experimental conditions (*browse*: $U=96$, $N=5,5$; $P=0.005$; *graze*: $U=126$, $N=5,5$; $P=0.036$). These differences lay in the afternoon session for browse ($U=18$; $N=5,5$; $P=0.019$), with no difference occurring in grazing levels in the male when the morning and afternoon sessions were examined independently.

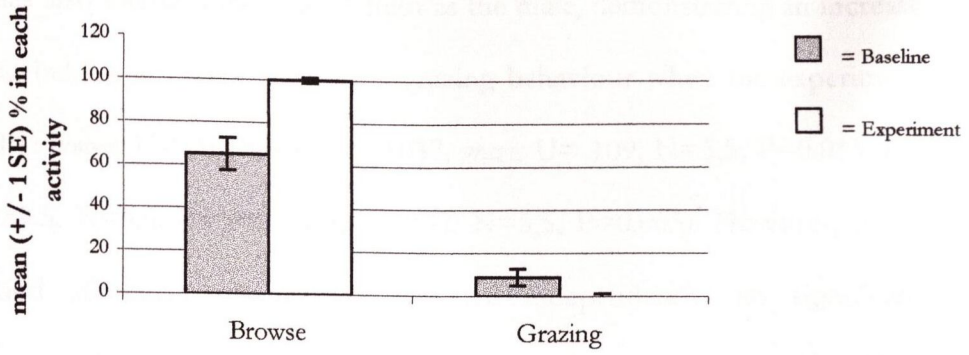


Fig 8.5a: Graph showing the difference between the baseline and the experiment, for the male giraffe for the entire day

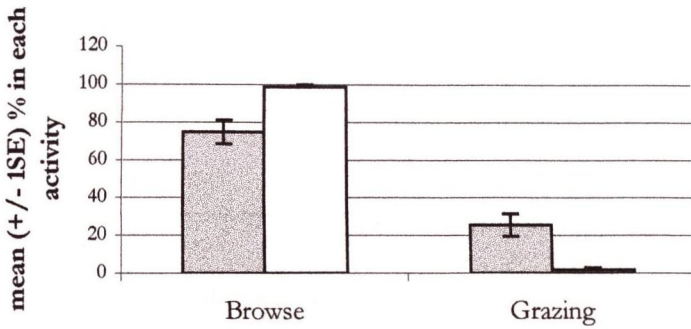


Fig 8.5b: Graph showing the difference between the baseline and the experiment for the female F1 giraffe for the entire day

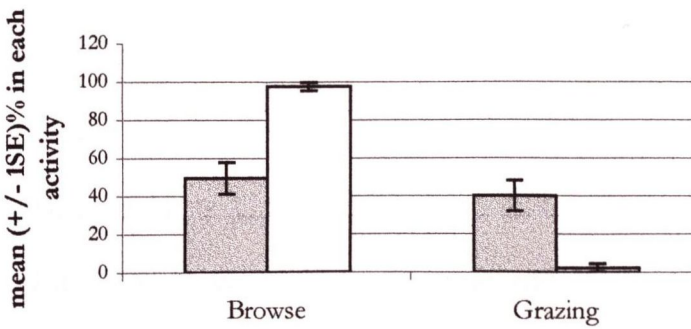


Fig 8.5c: Graph showing the difference between the baseline and the experiment, for the female F2 giraffe for the entire day

Both females also followed the same pattern as the male, demonstrating an increase in browsing behaviour and a decrease in grazing behaviour when the experiment occurred (F1: *browse*: $U=110$; $N=5,5$; $P=0.037$, *graze*: $U=109$, $N=5,5$; $P=0.035$; F2: *browse*: $U=59.5$, $N=5,5$; $P=0.001$; *graze*: $U=82$, $N=5,5$; $P=0.005$). However, if the morning and afternoon session are examined independently, no significant difference was observed between the baseline and the experiment for either browsing or grazing levels in the F1 female. The F2 female did show differences in the morning and afternoon sessions with browsing levels increasing in both sessions (*morning*: $U=21$, $N=5,5$; $P=0.042$; *afternoon*: $U=5$, $N=5,5$; $P=0.001$), during the experimental conditions, and a decrease in grazing levels in the afternoon session ($U=5$, $N=5,5$; $P=0.001$).

Reasons for these differences in the browsing and grazing levels in the individuals will be discussed in section 8.4.

Comparing Individuals

The individuals showed differences in the amount of time spent browsing (figure 8.6a) and grazing (figure 8.6b) in the baseline conditions only (*browse*: $\chi^2 = 6.966$, $df=2$, $P=0.003$; *graze*: $\chi^2 = 11.068$, $df,P=0.001$). Post hoc analysis shows that for browse, no difference occurs between the male and F1 female, but that the F2 female browsed for significantly lower than both the male and the F1 female (Post hoc analysis: critical value: 16.14; critical difference: Male-F1= 17.21; F1 female -F2 female= 16.77; $N=5,5,5$; significant at $P<0.05$).

Post hoc analysis showed that the difference in grazing levels lay between the male and the F2 only, with the F2 female grazing for significantly more (Post

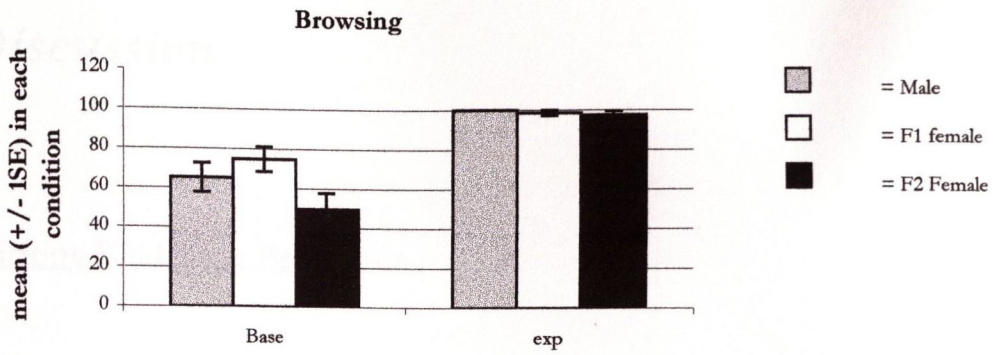


Fig 8.6a: Graph showing the difference occurring between the individuals in browsing levels

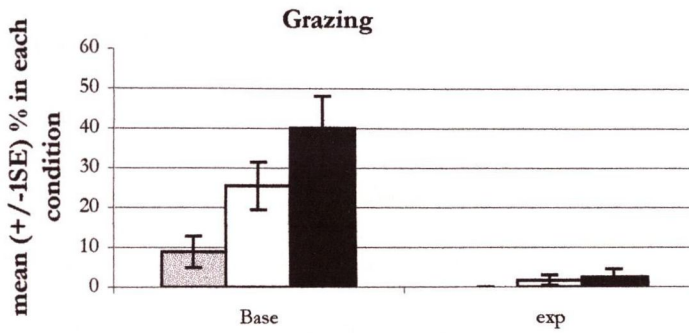


Fig 8.6b: Graph showing the difference occurring between the individuals in grazing levels

hoc analysis: critical value= 16.14; Male-F2 female=20.66; N=5,5,5; significant at $P < 0.05$).

In experimental conditions, when additional browse was made available to the giraffes, no difference between the individuals for either browsing or grazing levels were observed.

8.4 Discussion

8.4.1 Eliciting Wild Type Behaviour

This experiment aimed to increase feeding and feeding related behaviour to the same frequency that can be found in the wild i.e. 77.4% for the females and 55.4% for the male (Pellew 1984a). A common problem observed in zoo housed animals is the lack of wild type behaviour or the more infrequent occurrence of wild type behaviours. As well as these infrequent behaviours, often behaviours occur in captivity that are observed only in a captive environment. This often causes concern, particularly for species which are endangered and are on a reintroduction programme. Although giraffes are not threatened animals examination of their behaviours still remains important to ensure their overall well-being in captivity.

Since in the wild giraffes are exclusively browsers and often in captivity the amount of browse made available to them is often limited, this experiment provided the animals with additional browse. This enabled the effects on the giraffes' behaviour to be examined, when given the opportunity to increase their feeding levels to similar rate as observed in the wild.

8.4.2 Feeding

The results showed that despite being given the opportunity to increase their feeding to a level similar to that observed in the wild, the giraffes failed to do so. Although there were small increases in the amount of time spent feeding, these

increases were not significant in two out the three individuals. Even though a significant increase was observed in the F2 female, she did not increase her feeding levels to the same level as her wild counterparts but rather increased her level to a similar level to the F1 female. This result may be explained in terms of hierarchy.

The female F2 is the youngest member in the group and also appears to be the subordinate individual in the group. She was rarely if ever, observed feeding from the same browse poles with either of the other two individuals, particularly the male. This meant that the F2 female had to wait until the other two had fed for a sufficient amount of time before she could gain access to the browse that was left. The F2 female showed an increase in feeding both in the morning and afternoon sessions of experimental days, when additional browse was provided. This meant that there was available browse piles to feed from in the morning and afternoon that were not shared with the other two individuals. Further examination of feeding showed that indeed it was browsing which was increased in both sessions.

Although the other two individuals did not show significant changes in their feeding levels, closer examination revealed that they also increased their browsing levels significantly. Coinciding with these increases observed in browsing levels for all individuals, a decreases in grazing levels were also observed in experimental conditions. The male and F1 female reduced their grazing levels significantly to allow for a significant increase in browsing, without altering the total amount of time spent feeding, so that browsing made up almost 100% of their feeding time (see figure 8.6a). The same pattern was observed in the F2 female, however, since she had significantly lower browsing levels in the first instance, by increasing her browsing levels in the experimental conditions, her overall feeding level was significantly increased to that of the other female, even though she still demonstrated a reduction in grazing levels.

The fact that the giraffes did not increase their levels of feeding to the wild levels, suggests that perhaps in captivity, they are obtaining sufficient nutrients in their diet in a much shorter time, and therefore have no motivation to extend their feeding time beyond this. So, the fact that the F2 female increased only to the F1 females' experimental level, suggests that she may not have been obtaining a sufficient amount of food/ nutrients in the first instance.

This lower level of feeding in captivity leads to available time in their budget, therefore the animals must utilise this time to perform other behaviours that are perhaps not seen to the same frequency, if at all in the wild. Some examples of these behaviours are grazing and oral stereotypies.

8.4.3 Other Behavioural Categories

Although the feeding levels of the male and F1 female did not increase significantly, a reduction in other behavioural categories resulted. All three individuals demonstrated a significant reduction in foraging and licking behaviour.

The actual function of licking behaviour has often been debated. The fact that they were still feeding for the same total time suggests that they were not performing licking behaviour due to lack of food or boredom (since they still were left with the same amount of available time in their activity budget). It may have been related however, to their increase in browsing behaviour. When giraffes browse they utilise their tongues and orally manipulate the food more than when they graze. It is possible that licking behaviour acts as a replacement to this oral manipulation, and so, by increasing their browse intake they were able to carry out more oral manipulation resulting in the reduction of licking behaviour. In the wild giraffes are exclusively browsers and their favourite food is the *acacia* tree which is

very thorny. In order to be able to eat this, the giraffes must manipulate the branches to a great extent. In captivity, giraffes receive most of their nutrients by bulk feeding and often only have limited access to browse, hence, they receive very little oral stimulation to which they have adapted in the wild.

The male also showed a significant reduction in tongue playing behaviour with the provision of extra browse, which may be attributed to the same reasons as described above.

Foraging behaviour is a behaviour which occurred at quite low levels in the first baseline. With the provision of extra browse, foraging levels were depleted almost to a value of zero in all individuals. It is possible that their increase in browsing may also have been sufficient to reduce their need to search for additional food to very low levels.

Other changes that occurred with the provision of extra browse is a reduction in sexual and "other" behaviours in the male and a reduction in "other" and standing behaviours in the F2 female. The overall reduction of the male performing "other" and sexual behaviours occurred in the morning session only. The fact that the male made no attempt to increase these reduced behaviours in the afternoon period so that the overall levels remained the same, suggests that these behaviours may not be as important to the male as feeding or rumination for example, and that these behaviours are relatively elastic behaviours which are utilised to fill available time in his activity budget.

The F2 female also showed a reduction in "other" and standing behaviours, in the morning session only. As the female F2 did significantly increase her feeding levels in the morning, these behaviours may have been reduced to make available time in the budget so that feeding could be increased. That these behaviours and

not other behaviours were reduced, suggests that, like to the male, these behaviours may not be very important to the female and possess relatively elastic properties.

The F2 female also showed an increase in locomotory behaviour. This may be attributed to the fact that more browse piles were present in the experiment and the female spent more time wandering from one browse pile to the other, instead of having to stand and wait her turn for a pile to become free from the other individuals, which she previously did.

The F1 female did not show any other differences in any behavioural category except for licking and foraging behaviour described above.

8.4.4 Conclusion

The giraffes were provided with an opportunity to increase their feeding levels and alter their behavioural budgets to similar patterns as observed in the wild. The giraffes failed to increase their feeding levels significantly, however, their browsing levels did increase and resulted in alteration of behaviours in their activity budgets.

Despite some behaviours being reduced in the presence of additional browse, it does not necessarily follow that by performing these behaviours at a higher frequency in the first instance, their welfare was being compromised. These activities may be a method of adapting or coping in a captive environment and hence, in the absence of an ideal situation, these behaviours may in fact be positive functional behaviours which fill up available time in their budget.

A further in depth review on the significance of wild type behavioural patterns in captive environments will be discussed in chapter 11.

Mr. Nine

PREF

TESTING: Part

Preference Testing

Chapter Nine

PREFERENCE TESTING: Part 1

9.1 *Introduction*

Preference testing is a method whereby behaviours or commodities can be tested to examine which the animal exhibits a greater preference for. However, preference testing does not provide us with actual values, but rather provides us with a rank status of each commodity being tested in relation to the others (see chapter 1, section 1.12).

The most commonly discussed element of preference testing is elasticity and inelasticity, (see chapter 1 section 1.11 for definitions and discussion). In order to examine the relative inelasticities of the commodities tested, the change in commodity use when no cost is associated with access to that commodity, and the commodity having a cost must be assessed. The changes that occur will indicate for which commodity the animal is willing to work harder and hence the relative ranks of the commodities.

There are a number of aims of this section of the study. They are:-

- (i) To design a method for and assess the feasibility of preference testing in zoos.
- (ii) To refine the method so that simple and accurate analysis is practicable by non- specialists.
- (iii) To rank 3 commodities according to the preferences and inelasticities shown by captive tapirs.

This chapter deals with the first aim only, the next chapter, chapter 10 examines the other two aims; devising a simple method to rank preferences and using this to rank preferences for captive tapirs.

Preference testing was carried out on the tapirs but not giraffes, for husbandry and management reasons. Tapirs are much easier to work with and in Dublin and Fota, remain in one enclosure throughout the day, unlike the giraffes. This enables observations to be recorded for longer periods of time without interruption from husbandry practice.

Initially preference testing was to be carried out on 5 zoos, Dublin, Fota, Chester, Bristol and Paignton. However, due to the devastating outbreak of foot and mouth, this rendered it impossible to complete all five zoos. Three commodities were examined in both Dublin and Fota and one at Chester. The same basic method was carried out for all zoos examined.

9.2 Method

9.2.1 Experimental Design

The experimental set up comprised a separate area or room within or outside their usual inside enclosure. Each area/room had one point of entry only. This entry point could be obstructed by of a number of PVC “butcher flaps” 3mm thick, 300mm wide, which were hung to cover the entrance of the experimental area.

Three commodities were tested for both Dublin and Fota. These were -:

- Straw Bedding: this resource acted as a control for the other commodities as well as providing the animals with a sleeping quarter separate to their usual indoor area. This commodity tested the animals desire for a bedding area free from where feeding, defecating and keeper disturbances occurred.

It should be noted that straw bedding was also available to the tapirs in the usual indoor enclosure under normal husbandry regime.

- Starw Bedding + Browse: This commodity provided the tapirs with an area where they could gain additional food through browse, whilst also having an area to rest, see above.

It should be noted that under normal husbandry, browse was available to the individuals as an additional food source that was placed in their usual indoor quarters, hence availed of it without cost. During this trail however they were only provided

browse in the experimental area. This tested their preference to gain additional an additional food source when a price was been paid.

- Bare Room: The commodity tested here was the preference for additional space and solitude. Straw and browse were removed so that the tapirs were left with the same experimental area but with nothing in it.

It should be noted that under normal husbandry the animals had no access to this experimental area.

Each commodity was tested both when the flaps hindered the entrance of the area/room and when they were raised and did not cover the entrance. In other words the commodity was provided to the individuals both for free, and at a cost. Each commodity was replicated five times with the flaps in place and five times without. Days with and without were alternated. The absence of flaps i.e. “no flaps”, acted as a control which examined the individual’s willingness to enter the room when no additional work was required of them. The presence of flaps provided the challenge of having to work harder to push the flaps aside in order to gain access to the commodities. Although this did not provide a physical challenge to them, the tapirs still appeared reluctant to enter when flaps were in place.

Each morning at feeding time the flaps were either pulled down so an obstruction was caused or pushed clear so the tapirs had free access to the experimental area. This was done at feeding time as the tapirs were used to being disturbed by the keeper at this time and so no other disturbance was caused throughout the rest of the observation

period. It was also at this time when the various commodities were placed in the experimental area. Throughout of the rest of the observation period the tapirs' husbandry regime remained the same as during non experimental conditions.

The following categories were recorded for each commodity under each condition, for all individuals examined.

- (i) *Duration:* The total duration of time spent in the area/room recorded as percentage of total observation period.
- (ii) *Resource use:* The total time spent interacting with the commodity, recorded as percentage of total duration.
- (iii) *Latency:* The time taken before first initial interaction with the commodity occurred, recorded as percentage of total duration.
- (iv) *Entries:* The actual number of entries into the experimental area/room, recorded as number of entries per observation period.
- (v) *Attempts:* The number of attempted entries (but not actual entries) into experimental area/room, i.e. the sniffing of, or putting head only through doorway, recorded as number of attempts per observation period.

Since a bare room had no commodity with which to interact, resource use and latency recordings were not taken when examining a bare room.

Some observations were assisted using the same video recording equipment as described in chapter 7, section 7.2, for the giraffes' nocturnal observations. However, most observations were taken directly.

Dublin Zoo

The experimental area for these individuals was a separate room at the back of their inside enclosure (see fig. 9.1a). Under normal management the tapirs had no access to this room. The experimental design was as described above. Observations were recorded for a total of 13 hours, from 5am- 6pm, as the tapirs slept for most of their time outside of these hours.

Fota Wildlife Park

The Fota individuals were housed in a relatively small one roomed shed. To examine preferences in these individuals an area in their inside house was partitioned off where the commodities were being tested (see figure 9.1b). As with the Dublin individuals the design was as previously described. Observations were recorded for a total of 12 hours, from 5am-5pm. Due to the opening hours of the park it was not possible to observe the animals after 5pm. Observations between the hours of 5am-10am were collected using video recording equipment.

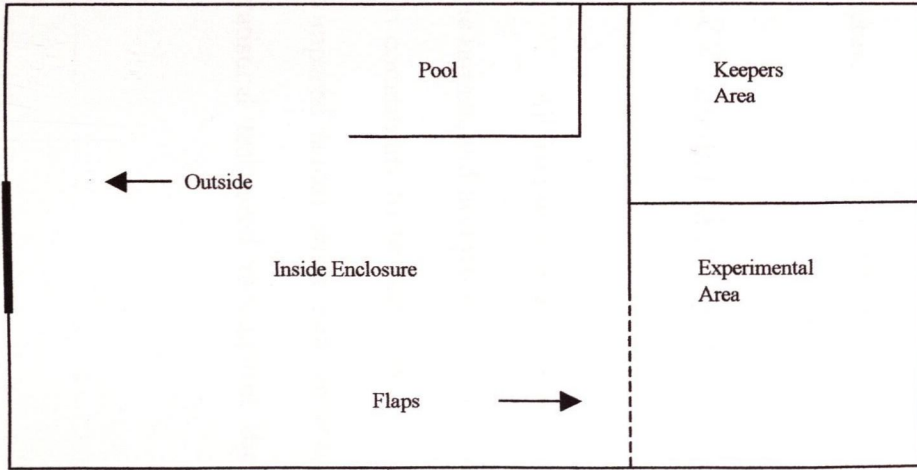


Fig 9.1a: Dublin Zoo*

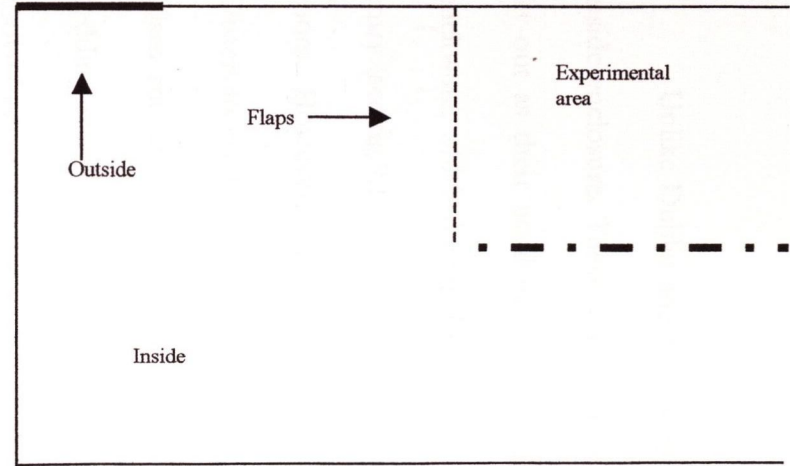


Fig 9.1b: Fota Wildlife Park*

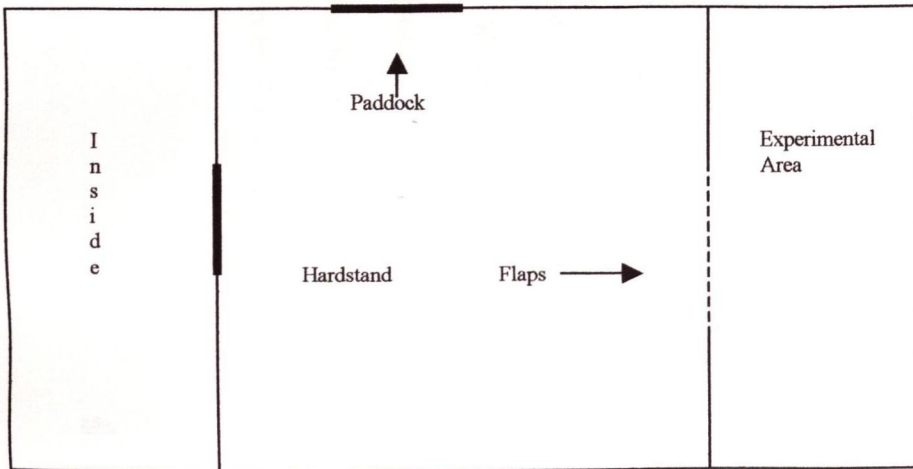
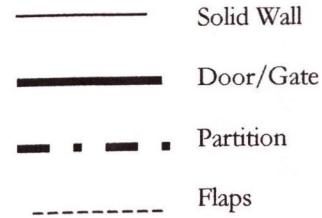


Fig 9.1c: Chester Zoo*



* not drawn to scale, see chapter 4 for dimensions

Chester Zoo

Unlike Dublin and Fota, Chester individuals were examined outside their usual inside enclosure. These individuals were given access to a room, which was the same lay-out as their usual inside enclosure. This room was located opposite their inside enclosure, which they had to leave and cross their hardstand paddock in order to gain entry (see fig.9.1c). Like the Dublin pair, these individuals also had no prior use of this room. However, unlike the previous two zoos, this pair had a juvenile present. Observations were recorded for five hours only from 10.00-15.00 hours, as before 10am and after 3pm the tapirs were usually locked into their inside enclosure. Straw bedding was the only commodity tested for these individuals, for reasons explained above (section 9.1).

When making comparisons between Dublin, Fota and Chester, the hours between 10.00-15.00 were extracted from Dublin and Fota observations, in order to ensure a valid unbiased comparison could be made.

9.2.2 Statistical Analysis

All data were non- normally distributed and so were examined statistically using the unmatched non parametric Mann Whitney U/ Kruskal Wallis tests. Since there was no commodity to be tested in the bare room, resource use and latency could only be compared across straw and browse commodities, hence Mann Whitney U was the statistical test used throughout the results section for these categories. A 3-way

ANOVA was not used as this test is used for parametric data and there is no equivalent for non parametric data. Graphs were constructed using SPSS and Microsoft EXCEL.

9.3 Results

9.3.1 Comparisons Within Individual Zoos

Dublin Zoo

Figure 9.2 shows the mean (± 1 SE) percentage (duration; resource use; latency) and frequency (attempts; entries) of recordings taken at Dublin zoo for each individual and commodity under each condition. Table 9.1 Appendix 4, shows the critical differences and significances for post hoc analysis.

When commodities were compared under the condition of “no flaps”, the male’s response to the different commodities varied significantly for all categories except latency, (duration: $\chi^2 = 9.551$, $df=2$, $P=0.008$; resource use: $U=0$; $N=5,5$; $P=0.009$; entries: $\chi^2=11.748$, $df=2$; $P=0.003$; attempts: $\chi^2 = 7.733$, $df=2$; $P=0.021$). Post hoc analysis show that the male spent less time and had a greater number of attempted entries in the “bare room” compared to the other two commodities (see table 9.1 Appendix 4).

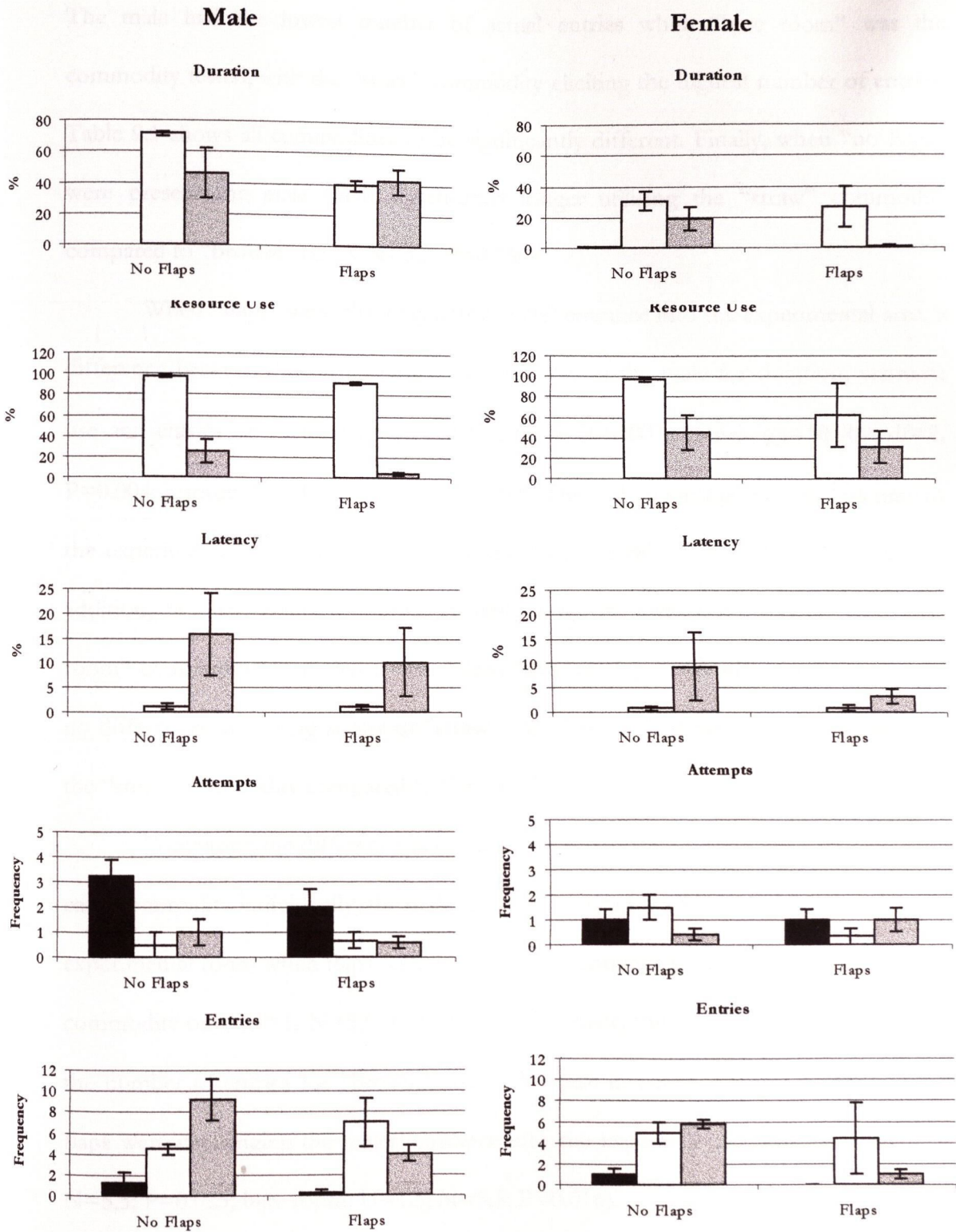


Fig 9.2: Graph showing the mean differences (± 1 SE) between the commodities for both the male and female tapirs at Dublin zoo, both with flaps and without flaps, in the doorway

■ = Bare Room ■ = Straw □ = Browse

The male had the lowest number of actual entries when “bare room” was the commodity tested, with the “straw” commodity eliciting the highest number of entries. Table 9.1 shows all commodities to be significantly different. Finally, when “no flaps” were present the male spent significantly longer utilising the “straw” commodity compared to “browse” ($U=3$; $N=5,5$, $P=0.036$).

When “flaps” were challenging the males’ entrance into the experimental area, a difference between the commodities was observed in the male for duration, resource use and entries only (duration: $\chi^2=9.958$, $df=2$, $P=0.007$; entries: $\chi^2=10.909$, $df=2$, $P=0.004$; resource use: $U=0$, $N=5,5$; $P=0.009$). The male spent significantly less time in the experimental room when examining the “bare room” compared to “browse”. In addition, he also entered the experimental room on fewer occasions for the “bare room” commodity compared to the “straw” commodity. Although the male showed no differences in gaining access to “straw” and “browse”, he spent more time utilising the “straw” commodity compared to “browse”.

Comparing the difference between the conditions i.e. “flaps” and “no flaps” for each commodity individually, the male spent a significantly shorter period of time in the experimental room when flaps were hindering the entrance to the room for the “straw” commodity only ($U=1$; $N=5,5$; $P=0.009$). Additionally, the male showed an increase in the number of entries for “browse”, but a decrease in entries for “bare room”, when flaps were challenging the males’ entrance into the experimental room (browse: $U=2$; $N=5,5$; $P=0.025$; bare room: $U=1.5$; $N=5,5$; $P=0.016$).

Like the male, the female showed a significant difference in her response to the commodities for duration, resource use and number of entries, but not attempts when flaps were absent (see fig 9.2) (duration: $\chi^2=9.637$, $df=2$, $P<0.008$; entries: $\chi^2=9.889$,

df=2, $P=0.007$; resource use: $U=1$; $N=5,5$; $P=0.009$). The female spent less time and made fewer entries into the experimental room when "bare room" was the commodity tested, compared to the other two commodities, where no difference occurred (see Appendix 4 table 9.1). Also like the male, when flaps were absent, the female spent more time utilising the "straw" commodity than "browse".

When the flaps were present the female demonstrated differences between the commodities in the amount of time she spent in the experimental room (duration) and the number of times she entered the room (entries), only (duration: $\chi^2=7.641$, df= 2, $P=0.002$; entries: $\chi^2=7.267$, df=2, $P=0.007$). The female spent a significantly longer duration in the experimental room when "straw" was the commodity, compared to the other two commodities, where no difference occurred. Conversely, no difference was observed in the female between "bare room" and "browse" in the number of entries, but both had a lower number of entries than the "straw" commodity (table 9.1).

A comparison between the females' response to the absence and presence flaps shows no effect of flaps on her response to the bare room. When "browse" was the commodity offered, she spent longer in the experimental room and had a significantly higher number of entries when "no flaps" were hindering her access to the room (duration: $U=1.5$; $N=5,5$; $P=0.008$; entries: $U=1$; $N=5,5$; $P=0.009$). Furthermore, the female showed a decrease in the number of attempts made for the straw commodity when flaps were present ($U=3$; $N=5,5$; $P=0.031$).

The individual differences between the male and the female were also compared. When "no flaps" were present, the female spent less time and had fewer entries for the "browse" commodity when compared to the male (duration: $U=0$; $N=5,5$; $P=0.007$; entries: $U=3$; $N=5,5$; $P=0.041$). The male also attempted entries at a

higher frequency when a "bare room" was being examined ($U=0.5$; $N=5,5$; $P=0.025$) compared to the female.

When flaps were present the female once again spent less time and had fewer entries into the experimental room, than the male for the "browse" commodity only (duration: $U=1$; $N=5,5$; $P=0.008$, entries: $U=1$; $N=5,5$; $P=0.008$). No other differences were observed between the male and female in the presence of flaps.

Fota Wildlife Park

Figure 9.3 shows the mean (± 1 SE) percentage (duration; resource use; latency) and frequency (attempts; entries) of recordings taken at Fota Wildlife Park for each individual and commodity under each condition.

When no flaps were present the male showed a significant difference in his duration in the experimental area and use of the resource (duration: $\chi^2=9.472$, $df=2$, $P=0.009$; resource use: $U=3$, $N=5,5$; $P=0.001$). The male spent longer in the experimental room and spent a greater amount of time engaged in resource use, when "straw" was the commodity tested, compared to both "bare room" and "browse" for duration, and "browse" for resource use (see Appendix 4 table 9.1). In the presence of flaps, a difference between the commodities was observed between in the duration, resource use, and the number of entries and attempted entries performed by the male (duration: $\chi^2=11.180$, $df=2$, $P=0.004$;

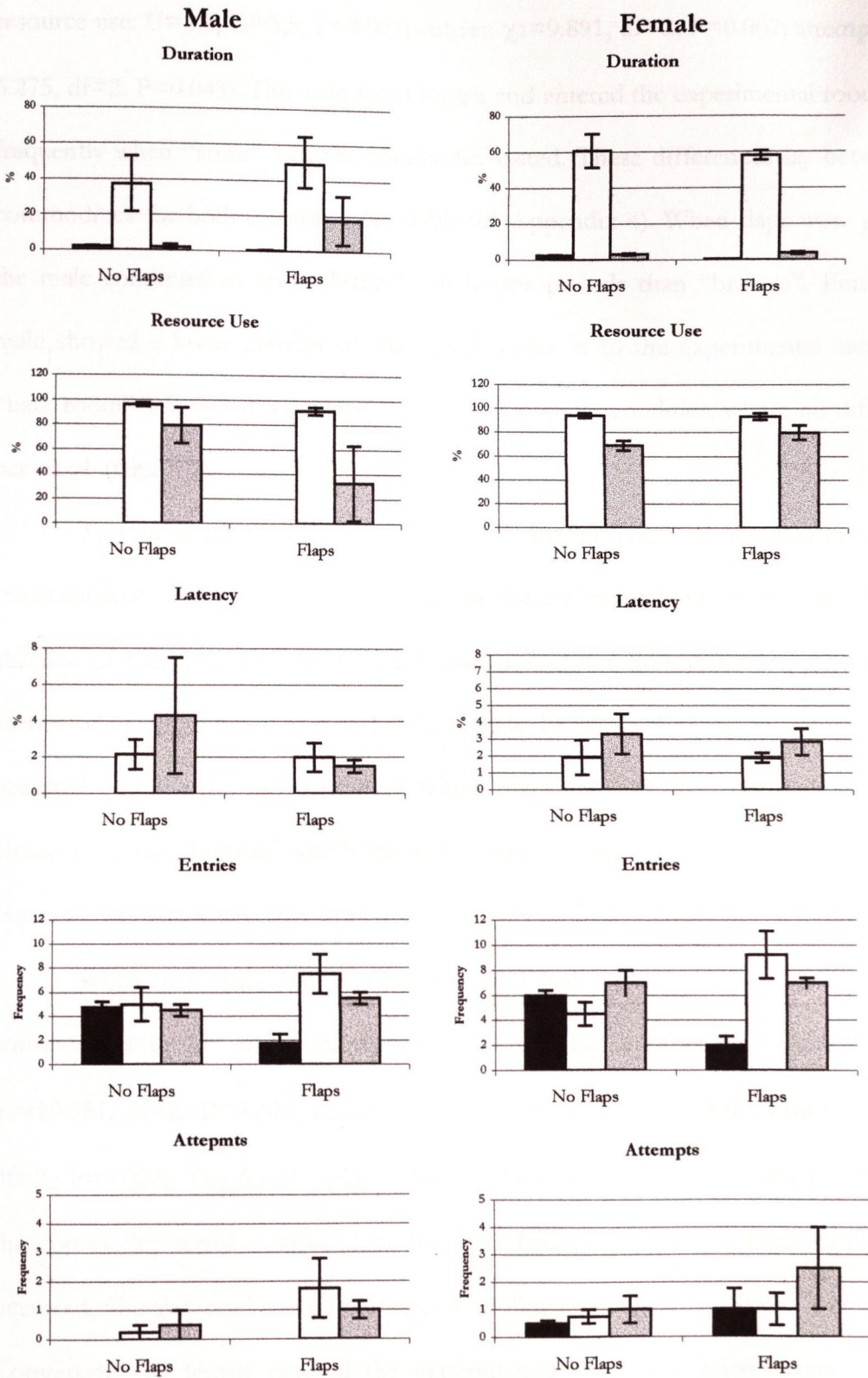


Fig 9.3: Graph showing the mean (+/- 1 SE) difference between the commodities for both the male and female tapirs at Fota Wildlife Park, both with flaps and without flaps placed in the doorway

= Bare room
 = Straw
 = Browse

resource use: $U=2.5$; $N=5,5$; $P=0.001$; entries: $\chi^2=9.891$, $df=2$, $P=0.007$; attempts: $\chi^2=6.275$, $df=2$; $P=0.043$). The male spent longer and entered the experimental room more frequently when "straw" was the commodity tested. These differences lay between all commodities for both categories (see table 9.1 Appendix 4). When flaps were present, the male continued to utilise "straw" for longer periods than "browse". Finally, the male showed a lower number of attempted entries in to the experimental area when "bare room" was tested compared to the other two commodities, where no difference occurred (table 9.1).

To look at the effect of having to work that bit harder to obtain commodities, statistical analysis was carried out to examine the difference between the presence and absence of flaps. In response to the "bare room", the male reduced his number of entries when flaps were present ($U=1$; $N=5,5$; $P=0.013$). No significant differences occurred between the two conditions when "straw" was the commodity being tested. However, when "browse" was being tested, the male spent significantly longer in the experimental area when flaps were present ($U=1$; $N=5,5$; $P=0.009$).

When no flaps were present, the female responded differently to the commodities in her duration, resource use and the number of entries (duration: $\chi^2=10.751$, $df=2$; $P=0.005$; resource use: $U=1.5$; $N=5,5$; $P=0.009$; entries: $\chi^2=7.425$, $df=2$; $P=0.024$). The female spent longer in the experimental room when "straw" was the commodity tested compared to the other two commodities, where no difference occurred. She also used straw for longer than "browse" when "no flaps" were present. Conversely, the female entered the experimental room less when "straw" was the commodity tested, compared to either "browse" or "bare room" (Appendix 4, table 9.1).

9.3.2 Like the male, when flaps were present the female also showed a preference for the "straw" commodity in her duration, resource use and number of entries (duration: $\chi^2= 12.545$, $df=2$, $P=0.002$; resource use: $U=1$, $N=5,5$; $P=0.016$; entries: $\chi^2= 10.079$, $df=2$, $P=0.006$). No difference occurred in the female in the amount of time she spent in the experimental area between "bare room " and "browse", however, a difference occurred between all commodities for the number of entries, with "bare room" causing the fewest entries (see Appendix 4, table 9.1).

Comparing the conditions in the female i.e flaps *versus* no flaps, the only significant differences were found to be in response to the "bare room". The female spent longer and entered more frequently when "no flaps" were hindering access to the experimental area (duration: $U=01$; $N=5,5$; $P=0.009$; entries: $U=2$; $N=5,5$; $P=0.008$).

The two tapirs responded similarly to the experiment, the only difference occurred between the two individuals in the amount of time spent in the experimental area for "browse", which was higher in the male when flaps were present ($U=1$; $N=5,5$; $P=0.009$).

Chester Zoo

The Chester individuals were given the "straw" commodity only, with and without flaps blocking their access to the experimental room. The male and the female did not differ in their responses to the commodity in either condition, i.e. flaps or no flaps. Furthermore, the presence of the flaps made no difference to either of their responses to this commodity.

9.3.2 A Comparison Between Zoos

Usually data is only pooled when there is no difference observed between the samples. When comparing the preferences between individuals within each zoo, various differences were observed occurring between the male and the female. Now, in order to examine the differences between zoos these two data sets had to be pooled. So, in order to viably pool the two samples, the male and female data were treated as independent replicates and not two different sample sets, and hence the sample size (using reasoning described in chapter 4) was then ten and not five as earlier.

Dublin versus Fota

Figure 9.4 illustrates a comparison between Dublin zoo and Fota Wildlife Park, showing the differences occurring between commodities and each condition.

When no flaps were present there were some differences observed between the two zoos for the commodities. When a “bare room” was being tested the Fota animals spent significantly longer in the experimental room and entered a higher number of times than the Dublin individuals (duration: $U=0$, $N=10,10$; $P=0.001$; entry: $U=1$, $N=10,10$; $P=0.001$). However, in the number of attempts, Dublin exhibited a higher frequency than Fota ($U=5$; $N=10,10$; $P=0.001$). When “browse” was the commodity tested, Fota exhibited a lower duration and higher resource use than Dublin (duration: $U=3$; $N=10,10$; $P=0.01$ resource use: $U=15.5$; $N=10,10$; $P=0.009$). Dublin also showed a higher resource use than Fota for the straw commodity ($U=22.5$; $N=10,10$; $P=0.037$), although from the graph the difference appears minimal.

When flaps were present, differences were observed between the two groups for all commodities. Fota had a higher number of entries in “bare room” and “browse” commodities (bare: $U=2.5$; $N=10,10$; $P=0.001$; browse: $U=14$, $N=10,10$; $P=0.006$). Fota individuals also spent more time than Dublin individuals in the experimental room for “bare room” and “straw” commodities (bare room: $U=3$; $N=10,10$; $P=0.001$; straw: $U=12$; $N=10,10$; $P=0.004$). Furthermore, Fota individuals spent a greater proportion of time utilising the “browse” commodity than the Dublin individuals ($U=16$; $N=10,10$; $P=0.001$).

The differences between the presence and absence of flaps were also compared for each zoo. The Dublin individuals showed that the absence of flaps encouraged them to use the commodities more than when flaps were present (Bare room: *duration*: $U=23.5$; $N=10,10$; $P=0.018$; *entries*: $U=23$; $N=10,10$; $P=0.016$; Straw: *resource use*: $U=22$; $N=10,10$; $P=0.033$; Browse: *entries*: $U=6.5$, $N=10,10$; $P=0.001$).

Similarly, the Fota individuals gained higher behavioural scores in the absence of flaps, except for the amount of time they spent in the experimental area for the “browse” commodity, and the number of entries for the “straw” commodity, where results were higher when flaps were present (Bare room: *duration*: $U=0$; $N=10,10$; $P=0.001$; *entries*: $U=2$; $N=10,10$; $P=0.001$; Straw: *entries*: $U=18.5$; $N=10,10$; $P=0.016$; Browse: *duration*: $U=21$; $N=10,10$; $P=0.028$; *latency*: $U=16.5$; $N=10,10$; $P=0.011$).

Dublin versus Fota versus Chester (Straw commodity)

When examining the difference in the straw commodity between the zoos it must be noted that Chester zoo data were recorded between the hours of 10am and 3pm only,

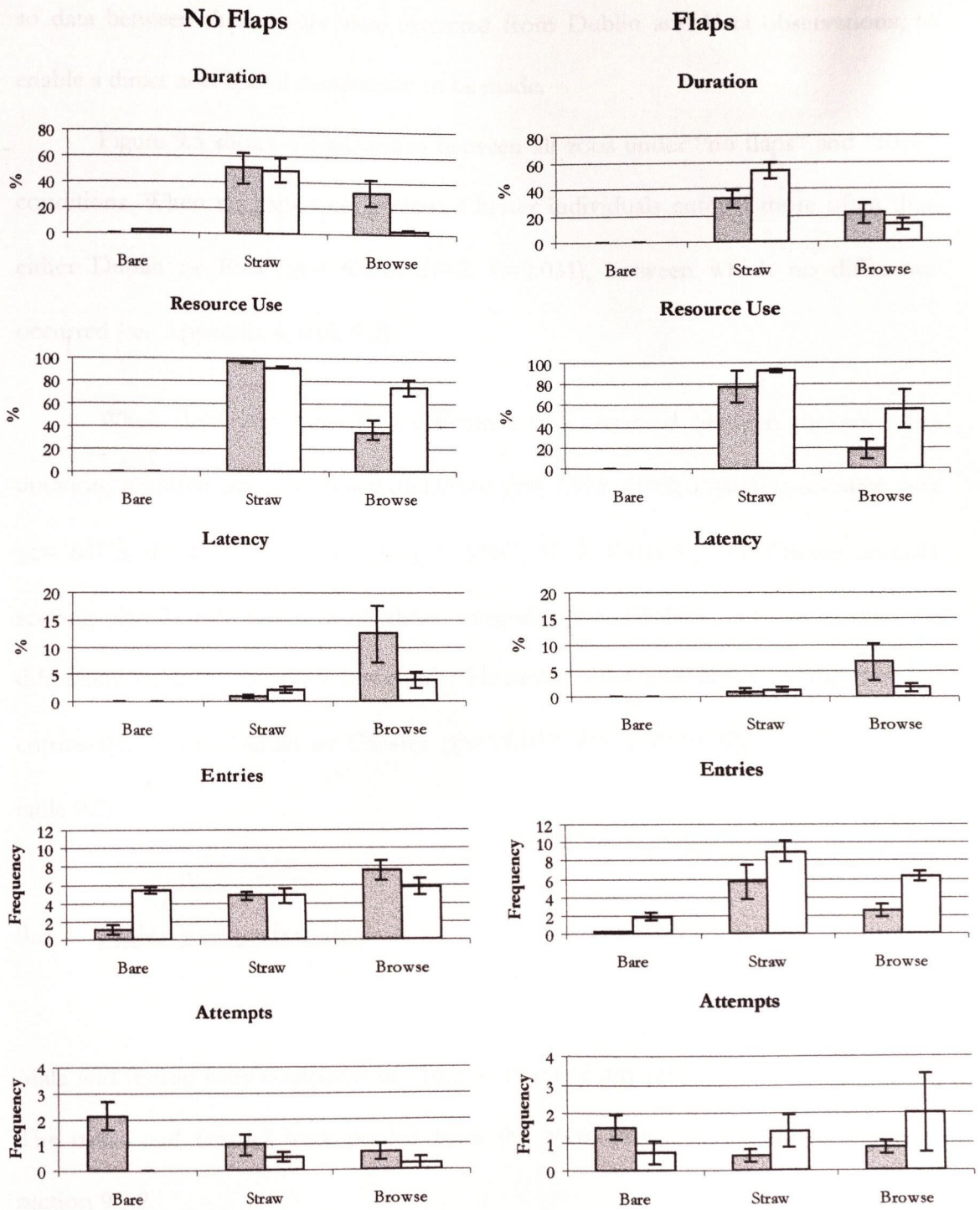


Fig 9.4: Graph showing the difference (± 1 SE) between Dublin and Fota zoo for each commodity tested under each condition

■ = Dublin □ = Fota

so data between these hours were extracted from Dublin and Fota observations, to enable a direct non-biased comparison to be made.

Figure 9.5 shows a comparison between all zoos under “no flaps” and “flaps” conditions. When no flaps were present, Chester individuals entered more often than either Dublin or Fota ($\chi^2= 6.950$, $df=2$, $P=0.031$), between which no difference occurred (see Appendix 4, table 9.2)

When flaps were present a difference was observed between the zoos for duration, resource use and latency (duration: $\chi^2= 7.945$; $df=2$; $P=0.021$; resource use: $\chi^2= 8.075$, $df=2$, $P=0.018$; latency: $\chi^2= 5.987$, $df=2$, $P=0.05$), with Chester animals scoring significantly lower in all these categories than Dublin and Fota, while no difference occurred between these two. However, Fota individuals exhibited fewer entries than either Dublin or Chester ($\chi^2=12.677$; $df=2$; $P=0.002$) (see Appendix 4, table 9.2).

9.3.3 Males Versus females

Male and female were compared in order to examine any inter-sex related differences. The males and females were pooled from the zoos, this was viable as explained in section 9.3.2.

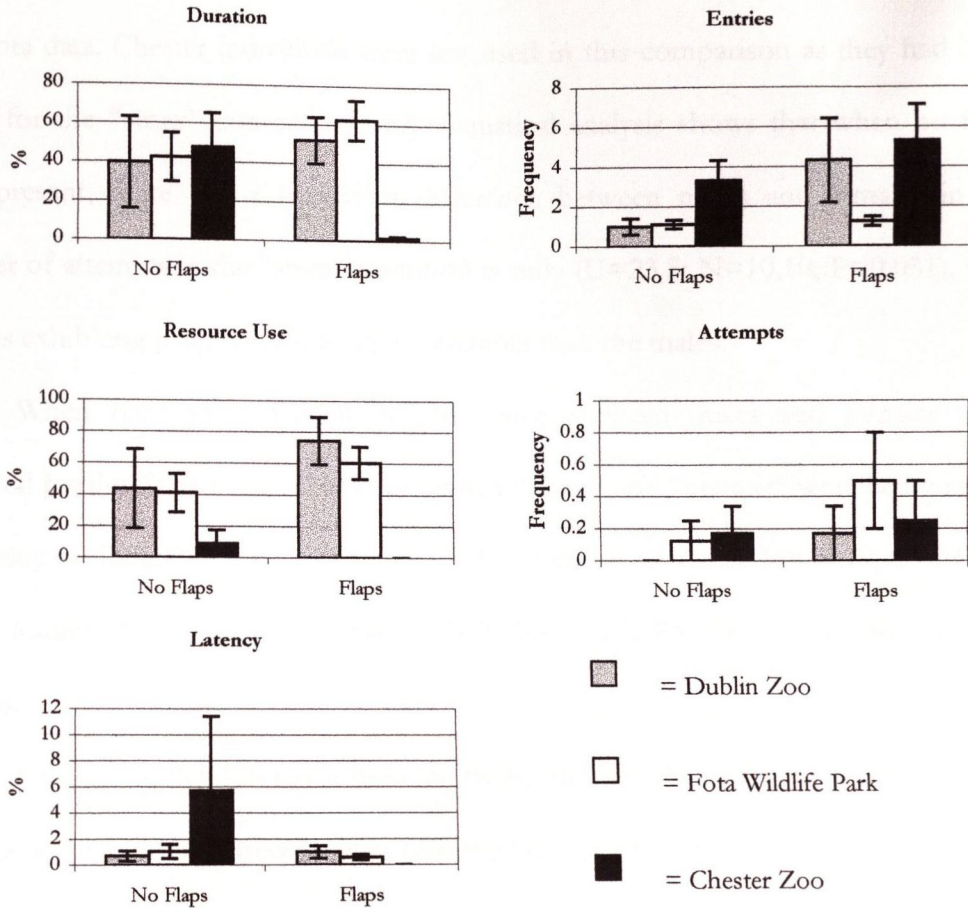


Fig 9.5: Graph showing the difference ($\pm 1SE$) across the zoos for the straw commodity only under each condition.

Figure 9.6 shows a comparison between males and females pooled from Dublin and Fota data. Chester individuals were not used in this comparison as they had been tested for the “straw” commodity only. Statistical analysis shows that when no flaps were present, there was a significant difference between males and females in the number of attempts in the “straw” commodity only ($U=23.5$; $N=10,10$; $P=0.031$), with females exhibiting a higher frequency of attempts than the males.

When flaps were present no difference between males and females were observed for the “bare room”. However, when “straw” and “browse” were being tested the males exhibited longer latency periods for “straw” ($U=23.5$, $N=10,10$; $P=0.004$), and a longer duration for “browse” ($U=0$; $N=10,10$; $P=0.001$), compared to the females.

Comparing the difference between males and females across all zoos, including Chester, no significant difference was observed in any category either in the absence or presence of flaps.

9.4 *Discussion*

9.4.1 Preference Testing

Preference testing is a method where an animal’s preference for a particular behaviour or commodity can be tested. In order to be able to establish ranked priorities of commodities in relation to one another, preference testing may or may not involve challenging the individuals access to the commodity.

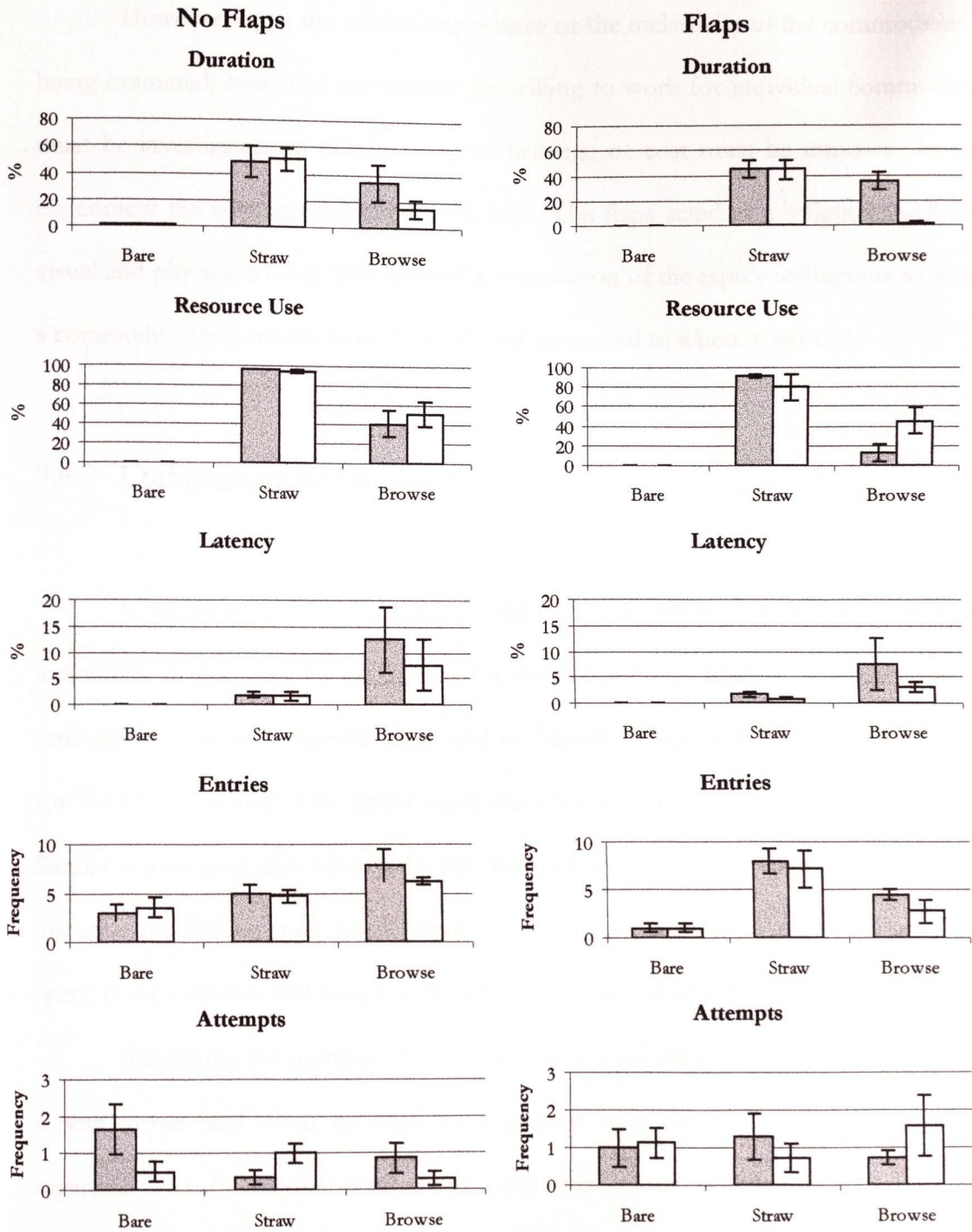


Fig 9.6: Graph showing the differences (\pm 1SE) between males and females when pooled from both Dublin and Fota

■ = Males □ = Females

However, when the relative importance or the inelasticity of the commodities is being examined, how hard the animals are willing to work for individual commodities must be investigated. In this instance, a challenge or cost must be imposed. In this experiment the cost was the addition of flaps. The flaps acted as a weight as well as a visual and physical barrier. This allowed a comparison of the tapir's willingness to reach a commodity when access carried a small cost compared to when it was free.

9.4.2 Comparisons Within Zoos

Examining both Dublin and Fota independently when no flaps were present, all individuals demonstrated a preference for the "straw" commodity, in the amount of time spent in the experimental room and the length of time using the resource, except for the Dublin female, who spent equal amounts of time with "straw" and "browse". Similar results were also observed when the cost was imposed ("flaps"), except in this instance, the Dublin male rated "straw" and "browse" equally in the amount of time spent in the experimental area, and the Dublin female did so for resource use.

Examining the number of times each individual entered the experimental room, it was shown that when no flaps were present both the Dublin and Fota females regarded "straw" and "browse" as of equal importance, however, the Dublin male demonstrated a preference for "browse" over the other commodities. The Fota male on the other hand, showed no distinction between any of the commodities in the number of entries into the experimental area. When flaps were present, the Dublin female demonstrated the same preferences, however, the Dublin male now regarded "straw" and "browse" equally. In the presence of flaps, the Fota individuals showed a

distinction between the commodities and were prepared to enter the area when "straw" was the commodity on offer, more often than for "bare room" or "browse".

It can be argued that the greater the duration, resource use and number of entries an individual exhibits for a commodity, the more preferred the commodity is. It would be expected that the more important a commodity is to an animal, the more time they would spend in the area where the resource occurs, enter the area more frequently and use the commodity for longer periods, than a commodity which was not so favourable to the animals. By this reasoning, it appears that the Fota individuals were demonstrating an overall preference for "straw" commodities, and the Dublin individuals had an equal preference for both "straw" and "browse", with perhaps a tendency leaning more towards "straw".

When no flaps were present, the Dublin male showed a greater number of attempted entries for the "bare room", conversely the Fota female showed the fewest attempts for the "bare room". However, the Dublin female and the Fota male both showed no difference between the commodities in the number of attempts. When flaps were present, neither the Fota individuals nor the Dublin female distinguished between any commodity, however, unlike "no flaps" the Dublin male now showed the fewest attempts to enter the "bare room". No individuals in either zoo, for any condition, demonstrated any distinction between the commodities for latency.

Again we can assume that the most preferred commodity would have the fewest amount of attempts and the shortest latency period. If a commodity was important, the animal would be expected to have completed a full entry into the experimental area and not just an attempt. Furthermore, if the animal was very interested in a commodity, they would not delay in using the resource, hence, their latency period would be

shorter. Thus, the few attempted entries to the "bare room" by the Fota female suggested a preference for this commodity when no flaps barred the way, and the Fota male showed this preference when the flaps were present. However, the Dublin male showed the opposite preference, with many aborted entries into the "bare room". Further examination of all the results need to be assessed before any explanation for these differences can be addressed.

Examination of the change occurring between the conditions (flaps and no flaps) for the commodities, can show the relative inelasticities of the commodities. By imposing a cost on the animals, the animals should show a willingness to work at least as hard, if not harder for more important or inelastic commodities. Using similar reasonings as above, if the duration, resource use and number of entries are examined for each commodity, the change occurring between the conditions can indicate the relative inelasticities of the commodities. If a commodity is important or relatively inelastic to the animal, these categories should demonstrate no change or an increase, when flaps are present. If, on the other hand, the commodities are not as important or have greater elasticity to the animal, then a decrease in these categories should be observed in the presence of "flaps".

Both the Dublin individuals showed a decrease in the number of entries when the flaps were impeding their access to "browse", suggesting that "browse" is the least important or inelastic commodity. However, for the Fota individuals, "bare room" elicited the fewest entries in the presence of flaps, indicating that "bare room" is the least preferred commodity.

On examination of the length of time the individuals spent in the experimental area, it can be seen that the Dublin male spent less time in the area when flaps were

present, when “straw” was the commodity. This was similar for the Dublin female for the “browse” commodity, and for the “bare room” in the Fota female. This suggests different preferences of commodities for each of the individuals, with the Dublin male rating “straw” as the least important commodity, the Dublin female rating “browse” at the least important and the Fota female rating “bare room” as the least important or most elastic commodity. The Fota male spent longer in the experimental room when “browse” was being tested, in the presence of flaps, suggesting that the Fota male rated “browse” as the most important and inelastic commodity.

Some differences were also observed for attempted entries and latency periods. The Fota male showed a decrease in latency period when flaps were present when “browse” was the commodity compared to other commodities, indicating a preference for “browse” in the Fota male. Additionally, the Dublin female showed a decrease in the number of attempted entries into the experimental area when flaps were present, for “straw”, indicating that the female placed a great importance on the “straw” commodity.

Once again, we can observe that individuals demonstrated different preferences depending on the category being examined. The indications of these results will be discussed in section 9.4.5.

9.4.3 A Comparison Across Zoos

To examine whether differences in preferences occurred between groups of tapirs, male and female data was pooled in each individual group and was compared

with the other group. In this case, a comparison was made between Dublin and Fota groups.

When “no flaps” were present Fota individuals spent more time the Dublin individuals in the experimental room, had a greater number of entries and fewer attempts when “bare room” was examined. This implies that Fota individuals showed a greater preference for a “bare room” than the Dublin group. However, the Dublin group showed a greater preference for “straw” and “browse” commodities over the Fota group by spending longer in the room when “browse” was tested and by utilizing the “straw” commodity for longer.

When “flaps” were present, Fota individuals demonstrated a greater preference for all commodities compared to the Dublin group. Fota individuals spent longer durations in the experimental room for “bare room ” and “straw” commodities, than the Dublin group. They had a higher number of entries for the “straw” and “browse” commodities. Also, they spent more time using the resource when “browse” was examined , compared to the Dublin individuals.

By examining each of the groups individually in section 9.4.2, on the whole we see similar preferences for commodities. However, by comparing across the zoos, although Dublin are showing similar preferences it appears that Fota individuals are showing a much stronger preference for these commodities than the Dublin group.

If the “straw” commodity is compared across all zoos, including Chester, a difference in the number of entries only occurred between the zoos, with Chester zoo having the highest number of entries than either Dublin or Fota.

9.4.4 Males Versus Females

Males and females were compared in order to ascertain if individual preferences could be observed and whether preferences may be related to sex. Males and females were compared in each individual zoo and then the sexes were pooled from all zoos and compared (See section 9.3.2).

When both “no flap” and “flaps” were examined in Dublin individuals, the male spent longer in the experimental area and had a greater number of entries than the female, when the commodity was “browse”, for both conditions. The Fota male also showed this for duration, but only in the presence of “flaps”. When “no flaps” were present no difference were observed between the male or the female. This suggests that for both zoos, the male showed a greater preference for “browse” than the female, except in the absence of flaps for the Fota individuals.

Pooling the sexes, results showed that in the absence of flaps, the females had greater number of attempts than the males for the “straw” commodity, suggesting that males had stronger preferences for “straw” than females. However, in the presence of “flaps” the males demonstrated longer latency periods for “straw”, which by using the assumptions, indicate that it is the females who show a greater preference for the “straw” commodity. If Chester individuals are also pooled, we then see no difference between the males and females for “straw”¹. In the presence of “flaps” the males spent longer durations in the experimental area for “browse” than the females. This implies that when access to the commodity has no cost involved, the males show a greater

¹ Note: When incorporating Chester data, Dublin and Fota had data extracted from their usual data set, for the same few hours of Chester individuals observation period. Hence, the contradictory results for the “straw” commodity.

preference for “straw”, however, once a cost is imposed the males switch their preference to ‘browse’ and the females show a greater preference for “straw” than the males.

9.4.5 Conclusion

The aim of this chapter was to design a method and assess the feasibility of preference testing in zoos. This method showed that there were indeed differences displayed between the commodities. Whether these differences were attributed to actual preferences or individual behaviour will be addressed in the following chapter, where analysis the data is examined. The key to preference testing is imposing a cost on the animal. Through this, various behaviours or commodities can be examined, and this test can be used for a variety of species using different commodities, depending on the species of study.

- (a) Ideally a 24 hour observation period should be used, unless the behavioural budget is thoroughly known, as in the case of the tapirs, and so, observation periods can be extracted. However, the longer the observation period the more accurate the results will be.
- (b) Conditions and husbandry of the animals must remain as consistent as possible throughout the experiment, so that the only changes occurring are the presence or absent of the cost. This ensures that no other factors are influencing the decisions of the animals for a given day.

- (c) One of the most important aspects of preference testing lies in the categories being observed. The above results have shown that if the length of time is the only category being looked at, a preference may be seen for “straw” for example, however, if the number of entries into the experimental area is examined a preference may be observed for “browse”. So, by using only one category, extremely contradictory results may be found, depending on which category is used. For this reason, all aspects of the animals’ behaviour must be looked at. In other words, the amount of time the animal spends in the area; the number of entries and attempted entries; how long it takes the animal to first interact with the resource and how long the animal spends interacting with the resource, ALL must be recorded to obtain a full accurate picture.

The results obtained have given very confusing contradictory results, and still haven’t really clarified where preferences lie. Usual statistical analysis such as Mann Whitney U or Kruskal wallis tests can provide information into the animals behaviour, but do not bring us any closer to obtaining definite information regarding their preferences. This means that some alternative method must be developed so that preferences can be distinguished, hence, a scoring system needs to be devised so that, information can be combined from all the different measurement types to give over all preferences. So, despite this chapter providing a simple, feasible, is that the results can be analysed.

The next chapter aims to do this. Chapter 10 aims to devise a method whereby the information is combined and the commodities can be ranked for preferences, hence, for the purpose of this study, information of the ranked preferences and inelasticities in captive tapirs can be established.

Chapter Ten

PREFERENCE TESTING: Part 2

10.1 *Introduction*

10.1.1 Aims

The previous chapter demonstrated that preference testing could be carried out feasibly in a zoo environment. However, it failed to combine the different behavioural categories in order to establish an overall rank of preferences.

This chapter aims to develop a method whereby all this information can be further analysed and combined, so that a ranked preference for each commodity in each condition can be obtained, as well as obtaining ranked inelasticities. The final aim of this chapter is to apply this ranking system to the tapirs data, whereby the preferences and inelasticities of three commodities may be ranked for captive tapirs.

10.1.2 Inelasticity

Dawkins (1990) argued that the slope of a demand curve (see below) is a suitable measure for examining how hard an animal is willing to work. She also argued that this is a valid method to assess if an animal is suffering. Matthews &

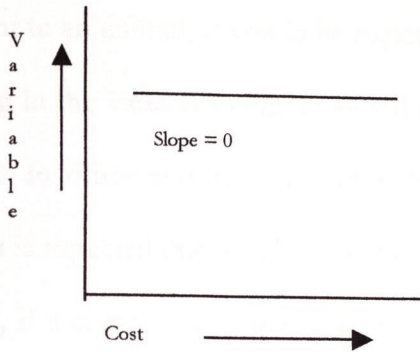


Fig 10.1a

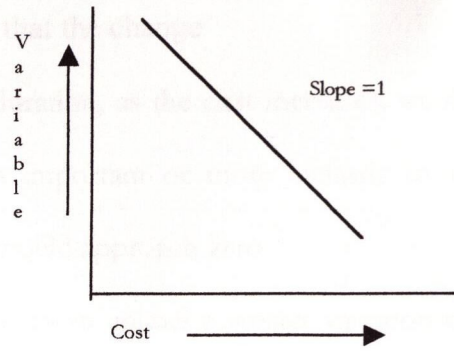


Fig 10.1b

Ladewig (1994), also implied that the demand elasticity can be quantified by measuring the slope of a function. However, this has been debated by Houston (1997), where he suggests it is in fact the area under a demand curve which depicts a more accurate picture of animal suffering. A demand curve relates the variable being examined with the price. Since this study is not concerned with obtaining actual inelasticity values for the commodities, but rather ranking how inelastic the commodities are in relation to one another, we need not pursue this argument. Furthermore, since this study is concerned with ranking inelasticities only and not attempting to measure whether the animal is suffering, the slope of the line rather than the area of demand, can be considered to give accurate representations of inelasticity.

How the slope is related to inelasticity can be explained by examining figures 10.1a and b. It can be seen in figure 10.1a, if the variable in question does not change e.g. the number of entries, as the x-value (or cost) increases, the resulting line has a slope equal to zero. However, if a large change occurs in the variable being measured (fig 10.1b), the slope of the line approaches a value of one. In this instance the variable would be duration for example and the cost would be

the presence of flaps. Relating this theory to preference testing, if a commodity is important to an animal, it would be expected that the change occurring in the variable being measured e.g duration, as the cost increases, would be small. In other words, if a commodity is important or more inelastic to an animal, it is expected that the slope of the line would approach zero.

Similarly, if a commodity was not as important to an animal a greater variation or change in the variable (in this case behaviour), would be observed as the cost increases, hence the less important a commodity, the more the slope would be inclined to approach one. Relating this to elasticity, the greater the inelasticity, the closer the slope value would be to zero and the greater the elasticity the closer the slope value would be to one.

The slope of the line of change, occurring between no cost and cost ("no flaps" and "flaps"), for a commodity was examined in this study as the slope has been documented to be valid indicator of elasticity.

10.2 *Method*

10.2.1 Ranking Preferences

In order to ascertain a preference between the commodities, a ranking order was established. A problem occurs with ranking the commodities in a normal fashion as there are differences between measurement types i.e. duration is measured as a percentage whereas the number of entries is measured as a frequency. In addition to this, the fact that one of the commodities i.e. bare room, does not

have resource use and latency recordings, makes comparing the commodities in an unbiased form relatively difficult. For this reason an alternative ranking method was established, that enabled a scoring system to be devised, which combined all the information from the different measurement types to give an overall preference in the animals.

The preference of a commodity by an animal, in relation to the other commodities being tested, can be established in whatever condition is required. The previous chapter demonstrated two conditions, they were “no flaps” and “flaps”. So, by examining each condition individually, relative preferences can be obtained both when the commodities are free and when they are available at a cost. As stated earlier, these preferences can only be ranked by combining the data obtained.

The information was combined and ranked by making a number of assumptions and by allocating a point system based on these assumptions.

- Assumption 1: The longer the *duration* the more preferred the commodity.
- Assumption 2: The greater the *resource use* the more preferred the commodity.
- Assumption 3: The shorter the *latency* the more preferred the commodity.
- Assumption 4: The higher the number of *entries* the more preferred the commodity.
- Assumption 5: The fewer *attempts* the more preferred the commodity.

Points:

- (a) If a commodity was statistically higher than the other two commodities, then 2 points was allocated to the highest commodity. If the second highest commodity was statistically higher than the lowest commodity, then the second highest commodity was allocated 1 point, and the lowest commodity 0 points.
- (b) If no statistical difference was observed between the two highest commodities, but both were statistically higher than the lowest commodity, then, the two highest commodities were allocated 1 point each and the lowest commodity 0 points.
- (c) If the highest commodity was statistically higher than the two lower commodities, with no significant difference between the two lower commodities, then the highest commodity was allocated 2 points and the two lower commodities were allocated 0 points each.
- (d) If no significant difference was observed between any of the commodities, then each commodity was allocated 0 points.

Note: All recordings taken were ranked this way except latency and the number of attempts, in which the lowest recording scored 2 and the highest scored 0, as these are converse measures (see assumptions).

Resource use and latency could not be recorded for “bare room”. In order to quantify a ranked number for all commodities equivalently, the rank status was

based on obtaining a proportional total from the maximum total that could be obtained for each commodity.

10.2.2 Ranking Inelasticities

Obtaining relative inelasticities is different from preferences in that inelasticity measures the change that occurs between the conditions, as opposed to taking each condition individually. Hence, if the change occurring between “no flaps” and “flaps” is examined for each measurement and each commodity, different assumptions and scoring methods must be established.

In this instance, the change occurring between “no flaps” and “flaps” should indicate for which commodity the animal is willing to work harder, and hence, which of the commodities the animals rate as of greater importance.

Similar to the previous ranking system, this method is also based on a number of assumptions and allocated points based on the following assumptions.

Assumption 1: The greater the importance, no change or an increase in *duration* should be observed in the presence of flaps, compared to “no flaps”.

Assumption 2: The greater the importance, no change or an increase in *resource use* should be observed in the presence of flaps, compared to “no flaps”.

Assumption 3: The greater the importance, no change or a decrease in *latency* should be observed in the presence of flaps, compared to “no flaps”.

Assumption 4: The greater the importance, no change or an increase in the number of *entries* should be observed in the presence of flaps, compared to “no flaps”.

Assumption 5: The greater the importance, no change or a fewer number of *attempts* should be observed in the presence of flaps, compared to “no flaps”.

Points:

- (a) If the value of a category in “no flaps” is significantly greater than when “flaps” are present, then **1** point is allocated.
- (b) If the value of a category demonstrates no change between “no flaps” and “flaps” then **2** points are allocated. However, if no difference is observed between the conditions, with the actual value being zero, **0** points are allocated.
- (c) If the measurement scores more when “flaps” were present compared to “no flaps”, then **3** points are allocated.

Note: As above, all recordings taken were ranked this way except latency and the number of attempts, which were allocated points in the same fashion except conversely, with the lowest receiving the higher points, (see assumptions).

As with ranked preferences, resource use and latency could not be recorded for “bare room”. In order to quantify a ranked number for all commodities equivalently, the rank status was based on obtaining a proportional total from the maximum total that could be obtained for each commodity.

10.2.3 Ranking Slopes

The slope of the lines occurring between the absence and presence of flaps for each commodity were also obtained for the purpose of this chapter (see section 10.1.2)

The equation for measuring the slope of a regression line is -:

$$b = \frac{n \sum xy - (\sum x)(\sum y)}{n \sum x^2 - (\sum x)^2}$$

where n= number of samples; x= the cost; y= the variable

All data were Log10 transformed to normalise the data. Log transformation was necessary due to the high variability in the data. For example, “bare room” data often consisted of very low values whereas “straw” and “browse” data consisted of very high values. In some instances, values of zero occurred in the data. Log10 (0) is equal to infinity, therefore, these data sets were transformed using Log10 (mean +1).

Once the slopes of the lines were obtained, a ranking method was used by allocating relevant points according to the slope value. The greater the inelasticity the closer the slope was to zero.

Points:

- (a) The closest slope value to zero was allocated **3** points
- (b) The second closet slope value to zero was allocated **2** points
- (c) The closest slope value to one was allocated **1** point

(d) If the commodity had an initial value of zero than 0 points were allocated

As with ranking the preferences and inelasticities, section 10.2.1 and 10.2.2, “bare room” did not have values for resource use or latency, so the proportion of the total number of points that could be obtained provided the figure that was ranked.

10.3 Results

10.3.1 Ranked Preferences

Using the ranking method described above in section 10.2.1 tables 10.1a and 10.1b have been constructed. These tables show the ranked preferences for commodities in relation to one another, for all combinations recorded in each condition. Points were awarded using the assumptions described in the method section 10.2.1.

Both tables contain a “total 1”, a “total 2” and a “total 1+2”. Total 1 is the sum of the scores for categories that could be recorded for all commodities. Total 2, provides the sum of the scores awarded for resource use and latency for “straw” and “browse” only; these categories are not applicable for the “bare room” commodity, for reasons described previously. Total 1+2 is the combined sum of the scores for all the categories, for each commodity. It is from these totals that the proportion values were obtained.

Proportional values were obtained for each commodity, so that the data could be examined without bias. Since the maximum score awarded was 2 points for each category, the maximum possible score for both “straw” and “browse” was 10 points. However, in the case of “bare room”, since resource use and latency were not applicable for this commodity, the maximum awarded could only be 6 points. So, the proportion was obtained by calculating the total number of points obtained out of the maximum points available.

The final row in the tables is the actual ranked number of the commodities in relation to one another. Rank 1, is the most preferred commodity and so, was allocated to the commodity which had the highest proportional value. Rank 3 is the least preferred commodity and hence, was allocated to the commodity with the lowest proportional value.

It can be seen from the tables 10.1a & b that in all combinations e.g. Dublin male only, Fota pooled, males pooled etc, the “straw” commodity was the highest ranked preference, both in the absence and presence of flaps. Furthermore, “browse” was the second highest and “bare room” was the lowest, in all but four cases, where they were equal.

10.3.2 Ranked Inelasticities

Table 10.2 shows the ranked inelasticity for each commodity. The ranked inelasticities inform us which commodities the animals were willing to work hardest for. The more inelastic a commodity, the harder an animal was willing to work, hence, the greater the importance of the commodity. Points were awarded as described in section 10.2.2.

	Dublin						Fota																	
	Male			Female			Male			Female														
	NF		F	NF		F	NF		F	NF		F												
	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw									
Duration	0	2	1	0	1	1	0	1	1	0	2	0	0	2	0	0	2	0	0	2	0			
Entries	0	2	1	0	1	1	0	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1
Attempts	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Total 1	0	5	3	0	3	3	1	3	2	0	3	1	0	2	0	0	4	3	0	2	0	0	3	1
Rank	3	1	2	2	1	1	3	1	2	3	1	2	2	1	2	3	1	2	2	1	2	3	1	2
Res Use	NA	2	0	NA	2	0	NA	0	0	NA	0	0	NA	2	0	NA	2	0	NA	2	0	NA	2	0
Latency	NA	2	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0
Total 2	NA	4	0	NA	2	0	NA	0	0	NA	0	0	NA	2	0	NA	2	0	NA	2	0	NA	2	0
Tot (1+2)	0	9	3	0	5	3	1	3	2	0	3	1	0	4	0	0	6	3	0	4	0	0	5	1
Propotion	0	0.9	0.3	0	0.5	0.3	0.17	0.3	0.2	0	0.3	0.1	0	0.4	0	0	0.6	0.3	0	0.4	0	0	0.5	0.1
Rank	3	1	2	3	1	2	3	1	2	3	1	2	2	1	2	3	1	2	2	1	2	3	1	2

F= Flaps

Br = Bare room

Sw = Straw

Bw =Browse

Res Use = Rsource use

Table 10.1a: Table showing the ranked preferences of the commodities tested for each individual both in the absence and presence of flaps.

	Dublin			Fota			Males			Females														
	NF		F	NF		F	NF		F	NF		F												
	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw									
Duration	0	1	1	0	1	1	0	2	0	0	2	1	0	1	1	0	1	1	0	2	1	0	2	0
Entries	0	1	2	0	2	1	0	0	0	0	2	1	0	0	2	0	2	1	0	0	2	0	2	0
Attempts	0	1	1	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Total 1	0	3	4	1	4	2	0	2	0	0	4	2	0	2	4	0	3	2	0	2	3	0	4	0
Rank	3	2	1	3	1	2	2	1	2	3	1	2	3	2	1	3	1	2	3	2	1	2	1	2
Res Use	NA	2	0	NA	2	0	NA	2	0	NA	2	0	NA	2	0	NA	2	0	NA	2	0	NA	0	0
Latency	NA	2	0	NA	2	0	NA	0	0	NA	0	0	NA	2	0	NA	0	0	NA	0	0	NA	0	0
Total 2	NA	4	0	NA	4	0	NA	2	0	NA	2	0	NA	4	0	NA	2	0	NA	2	0	NA	0	0
Tot (1+2)	0	7	4	1	8	2	0	4	0	0	6	2	0	6	4	0	5	2	0	4	3	0	4	0
Proportion	0	0.7	0.4	0.17	0.8	0.2	0	0.4	0	0	0.6	0.2	0	0.6	0.4	0	0.5	0.2	0	0.4	0.3	0	0.4	0
Rank	3	1	2	3	1	2	2	1	2	3	1	2	3	1	2	3	1	2	3	1	2	2	1	2

Table 10.1b: Table showing the ranked preferences for each commodity, when pooling each group examined, both in the absence and presence of flaps

	Dublin						Fota						Dublin			Fota			Males			Females					
	Males			Female			Males			Female			Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw
	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw
Duration	2	1	2	2	2	1	2	2	3	1	2	2	1	2	2	1	2	3	2	2	2	1	2	1	1	2	1
Entries	1	2	1	1	2	1	1	2	2	1	3	2	1	1	1	1	3	2	2	3	2	1	2	1	1	2	1
Attempts	2	2	2	0	3	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total 1	5	5	5	3	7	3	3	6	7	4	7	6	4	5	5	4	7	7	6	7	6	4	6	4	4	6	4
Rank	1	1	1	2	1	3	3	2	1	3	1	2	3	1	2	2	1	1	2	1	2	2	1	1	2	1	1
Res Use	NA	2	2	NA	2	2	NA	2	2	NA	2	2	NA	2	2	NA	2	2	NA	2	2	NA	2	2	NA	2	2
Latency	NA	2	2	NA	2	2	NA	2	1	NA	2	2	NA	2	2	NA	2	1	NA	2	2	NA	2	2	NA	2	2
Total 2	NA	4	4	NA	4	4	NA	4	3	NA	4	4	NA	4	4	NA	4	3	NA	4	4	NA	4	4	NA	4	4
Tot (1+2)	5	9	9	3	11	7	3	10	10	4	11	10	4	9	9	4	11	10	6	11	10	4	10	8	4	10	8
Proportion	0.55	0.6	0.6	0.33	0.73	0.46	0.33	0.73	0.73	0.44	0.73	0.67	0.44	0.6	0.6	0.44	0.73	0.67	0.6	0.73	0.67	0.44	0.67	0.53	0.44	0.67	0.53
Rank	2	1	1	3	1	2	3	1	1	3	1	2	2	1	1	3	1	2	3	1	2	3	1	2	3	1	2

Table 10.2: Table showing the commodities ranked for their relative inelasticities, for each combination recorded

Br = Bare room Sw =Straw Bw = Browse

The layout of table 10.2 is the same format as the tables described in section 10.3.1. In this case, it is the difference between the conditions which were ranked. In other words, scores were awarded based on the change occurring between the absence and presence of flaps.

“Straw” was demonstrated to be the most inelastic commodity for the females, while “straw” and “browse” tied first place when the males were considered separately. In all cases, “bare room” was ranked at being the most elastic commodity of the three. A discussion of these results, and their implications will be examined in section 10.4.

10.3.3 Ranked Slope

Figures 10.2 a-d (see Appendix 5a) show the difference in the slope of the lines for each commodity for each variable, for all combinations recorded.

The individual slope values for each line on the graphs can be seen in table 10.3 (see Appendix 5b). From the values in this table, table 10.4 was constructed in the same layout as the previous two tables.

As with the preference and inelasticity tables, the ranked slopes also demonstrate an overall ranked preference for the “straw” commodity, followed by “browse” and “bare room” being the less preferred commodity by all, except when the females’ data were pooled. When the female’ data were pooled, the females demonstrated a higher preference for “browse” over the “bare room” commodity.

Why the slope values were ranked in addition to the preference and the inelasticities will be discussed in the next section.

	Dublin						Fota						Dublin			Fota			Males			Females		
	Male			Female			Male			Female			Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw
	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw	Br	Sw	Bw												
Duration	1	2	3	2	3	1	2	3	1	1	3	2	1	2	3	1	3	2	1	2	3	1	3	2
Entries	1	3	2	2	3	1	1	2	3	1	2	3	1	3	2	1	2	3	1	3	2	1	3	2
Attempts	2	3	1	0*	2	3	0*	2	3	2	3	1	1	2	3	2	3	1	1	2	3	2	3	1
Total 1	4	8	6	4	8	5	3	7	7	4	8	6	3	6	8	4	8	6	3	7	8	4	9	5
Rank	3	1	2	3	1	2	2	1	1	3	1	2	3	2	1	3	1	2	3	2	1	3	1	2
Res Use	NA	2	1	NA	1	2	NA	2	1	NA	2	1	NA	2	1	NA	2	1	NA	2	1	NA	1	2
Latency	NA	2	1	NA	2	1	NA	2	1	NA	1	2	NA	2	1	NA	2	1	NA	2	1	NA	2	1
Total 2	NA	4	2	NA	3	3	NA	4	2	NA	3	3	NA	4	2	NA	4	2	NA	4	2	NA	3	3
Tot (1+2)	4	12	8	4	11	8	3	11	9	4	11	9	3	10	10	4	12	8	4	11	10	4	12	8
Proportion	0.44	0.92	0.61	0.44	0.84	0.61	0.33	0.84	0.69	0.44	0.84	0.69	0.33	0.77	0.77	0.44	0.92	0.61	0.44	0.84	0.77	0.44	0.92	0.61
Rank	3	1	2	3	1	2	3	1	2	3	2	1	3	1	1	3	1	2	3	1	2	3	1	2

Table 10.4: Table showing the ranked inelasticities of the commodities based on the actual slope values, for each combination recorded

Br= Bare room Sw = Straw Bw =Browse

0* = when the slope value equaled zero as a result of the original values being equal to zero

10.4 Discussion

10.4.1 Ranking Preferences

Table 10.5 shows a summary of the ranked preferences of the commodities tested for the captive tapirs, for all combinations recorded, both in the absence and presence of flaps.

From the table it can be seen that in each combination recorded, all individuals and all groups demonstrated the highest preference for “straw” compared to the other two commodities, both when the commodities were free and when a cost was imposed.

When the commodities were free, Fota individuals showed no distinction in their preferences between “browse” and “bare room” commodities and rated them both equally as the second preferred commodity. However, when a cost was imposed the individuals showed an increased preference for “browse” over a “bare room”. In other words, when a cost was imposed they no longer equated “browse” and “bare room” equivalently, a “bare room” held no greater value than the other two commodities if they had to work to get at it.

On the other hand, the Dublin individuals did show a difference between the two commodities, ranking “browse” as their second highest preferred commodity and “bare room” as their least preferred commodity, both in the absence and presence of flaps.

Examining the sexes, the males showed similar preferences to those above, when the commodities were free and when a cost was imposed. The females on the other hand, showed this for “no flaps” only, with no distinction being made between “browse” and “bare room” when “flaps” were present. So, when “no flaps” were present the females rated “browse” higher than the “bare room”, but in the presence of “flaps”, the females appear to have lowered their preference for “browse” and equated it of equally low preference to “bare room”. However, at all times for both sexes, “straw” remained the highest preferred commodity in both conditions of “no flaps” and “flaps”.

Since tapirs are herbivores and spend a majority of their time feeding in the wild, and since captive tapirs tend to feed for less than their wild counterparts (chapter 5), it was initially expected that the addition of food i.e. “browse” would have been the most preferred commodity, however, this does not appear to be the case. The “straw” commodity was the most preferred commodity in all instances. Possible reasons and further discussion of these results will be reviewed in section 10.4.5.

10.4.2 Ranked Inelasticities

Table 10.6 shows a summary of ranked inelasticities for each combination examined, that is, the ranked change that occurred between the two conditions tested i.e. “no flaps” and “flaps”.

Both males from Dublin and Fota demonstrated equally high inelastic properties for the “straw” and “browse” commodities, compared to the “bare room”. This was also true when the Dublin group were pooled. Examining the females in both groups, as well as Fota pooled and the sexes pooled, “straw” was

Rank	Dublin				Fota			
	Male		Female		Male		Female	
	NF	F	NF	F	NF	F	NF	F
1	Sw	Sw	Sw	Sw	Sw	Sw	Sw	Sw
2	Bw	Bw	Bw	Bw	Bw/Br	Bw	Bw/Br	Bw
3	Br	Br	Br	Br		Br		Br

Rank	Dublin		Fota		Males		Females	
	NF	F	NF	F	NF	F	NF	F
	1	Sw	Sw	Sw	Sw	Sw	Sw	Sw
2	Bw	Bw	Bw/Br	Bw	Bw	Bw	Bw	Bw/Br
3	Br	Br		Br	Br	Br	Br	

Table 10.5: Table showing the ranked positions for preferences of commodities, for each combination recorded

Rank	Dublin		Fota		Dublin	Fota	Males	Females
	Male	Female	Male	Female				
	1	Sw/Bw	Sw	Sw/Bw				
2	Br	Bw	Br	Bw	Br	Bw	Bw	Bw
3		Br		Br		Br	Br	Br

Table 10.6: Table showing the ranked positions of the relative inelasticities of the commodities, for each combination recorded

Rank	Dublin		Fota		Dublin	Fota	Males	Females
	Male	Female	Male	Female				
	1	Sw	Sw	Sw				
2	Bw	Bw	Bw	Bw	Br	Bw	Bw	Bw
3	Br	Br	Br	Br		Br	Br	Br

Table 10.7: Table showing the ranked positions of the relative inelasticities of the commodities using the slope values, for each combination recorded

Br = Bare room Sw = Straw Bw = Browse
 NF= No Flaps F= Flaps

rated to be more inelastic than "browse", but still, both showed to have higher inelastic properties than "bare room".

Comparing the inelasticities (table 10.6) and the preferences (table 10.5) for each individual, it can be seen that the two differ. For example, both the Dublin and Fota males rated "straw" above "browse", but both "straw" and "browse" as having equal inelastic properties.

10.4.3 Ranked Slopes

Table 10.7 shows a summary of the ranked slopes for all the individuals and combinations recorded.

The slope of the line can be a valid measure to assess relative inelasticities (section 10.1.2). All individuals and combinations of groups showed "straw" as the highest ranked inelasticity, followed by "browse" and then "bare room", except for when the Dublin group were pooled. When the Dublin group were pooled, "straw" and "browse" had equally high inelastic properties.

These results agree with the relative inelasticities presented in table 10.6, except for the Dublin and Fota males. In this measure by slope, these males demonstrated a distinction between "straw" and "browse" as seen in their preferences table (10.5), such that, both males now exhibited "straw" as the most inelastic commodity, followed by "browse" and with "bare room" being the least inelastic commodity.

10.4.4 The Lack of Preference for Additional Food

So, why is there a strong preference both in preferences and inelasticities for “straw” across the conditions? As previously stated, the results are surprising, since this test was conducted on a herbivore species, and it would be expected that food would always be the most preferred commodity. The results show that this is not the case.

Initially, when the Dublin data had been completed, but before Fota data had been taken, it was thought that the preference for straw bedding was largely due to the experimental area being out of the public’s view. The experimental room in Dublin was the only area in the tapirs’ enclosure which was unable to be viewed by the public. The fact that the individuals showed a marked preference across the conditions and demonstrated high inelastic properties for the “straw” commodity, suggested they rated having an area of privacy quite important, in fact so important, that it was even more important than additional food.

However, Fota individuals demonstrated the same results. Since the Fota individuals’ had no viewing window into their inside enclosure and at the time of observation the park was closed to the public, this theory was quickly discarded.

Another possible explanation for the preference of straw bedding over browse may be due to both females being pregnant at the time of study. Perhaps then this area of straw bedding acted as a nesting area. To date I have not been able to find any evidence or recordings of nesting behaviour in the wild, however, tapirs are elusive at the best of times, and so occurrence of this behaviour in the wild may not yet have been recorded. There is a problem with this theory as well however. If this preference were as a result of pregnancy, there should be a difference between Dublin and Fota females and the Chester female, since the Chester female was

definitely not pregnant as she had just recently given birth about a month previously, and no such difference was found. Furthermore, the higher number of entries in the Chester individuals, suggest they had a greater preference for the "straw" commodity than the other two groups examined. Additionally, similar preferences were also observed in the males

What about extra space? It cannot be said that the preference was in fact for additional area and not the straw bedding itself, since the Fota individuals did not acquire extra area in this experiment as no additional room was available hence, an area in their enclosure had to be partitioned off and so the area available to them remained the same. Furthermore, the distinct lack of preference occurring between all individuals for "bare room" indicated it was not just to have a separate or extra space.

So why then were the tapirs exhibiting a preference for straw bedding in a separate area? If the lifestyle of a tapir in the wild is looked at, this may bring us closer to an explanation. Little is known about the sleeping patterns of tapirs in the wild, they are extremely elusive animals and where they sleep is unknown. What is known however, is that they are solitary animals and solitary animals tend to find small hidden areas in dense vegetation to set their resting place. This protects them from predators and other species entering their territories. So perhaps this smaller area, that is away from the main area, where they are fed, defecate and often have keepers coming in and out, provides them with a secure resting place where they can feel safe and rest at ease.

10.4.5 Summary

This chapter provided three ranking tables, where the commodities tested were ranked. The first table comprised of general preferences among the commodities in relation to each other. Preferences were able to be obtained by ranking all conditions tested. The other two tables comprised inelasticity rankings, the first being compiled using a scoring system and the second using slope values.

To date preferences were obtained by assuming that the commodity with the highest inelasticity was the commodity that was most preferred. However, results have shown that this is not necessarily the case. For example, if we consider the Dublin group pooled, they show “straw” as the most *preferred* commodity over “browse”, however, both commodities have equal *inelasticity* levels. Preferences measure what the animal prefers or chooses, whereas inelasticity measures what IS important or cannot change in quantity. As Duncan (1978) suggested, animals, like people, may not always choose what is best for them. So, the animals may then choose a commodity that perhaps is not the most important to them. In other words, a difference may occur in what an animal wants and what they need.

As stated, preferences to date have been judged by inelasticities. These results suggest that they may be quite different. For this reason, an alternative method of ranking *preferences* was devised. Inelasticities were also ranked in a similar fashion to preferences, using a scoring system. The slope values were also ranked to provide an accepted method of ranking inelasticities, with which the two previous methods could be compared.

Comparing the ranked slopes with that of the newly devised inelasticity ranking method, it has been shown that ranked results are very similar. This implies that both methods give accurate results and that the assumptions used are valid

ones. Furthermore, since similar reasoning was used for the preference ranking and a similar scoring system, it is highly likely that if the inelasticity ranking method is a valid one, than so too, is the preference ranking method.

Since some commodities could not be separated initially prior to the slope ranking, this suggests that the difference between the commodities may have been small. The slope values enable a greater distinction to be made since the slope values are given to five decimal places and hence, can provide a more definite point allocation according to actual values, rather than assumptions.

However, the newly devised methods enable the actual values recorded to be used and ranked without log transformation. This method would probably be just as accurate as the slope method if a greater number of commodities were observed and if the cost had a continuously increasing price with which the commodities could be examined.

10.4.6 Conclusion

Chapter 9 showed that preference testing can be carried out feasibly in a zoo environment. This chapter provided guidelines on how to conduct preference testing, which would be viable to use on any species for any commodity or behaviour to be examined. This chapter devised ranking methods which could be used for a variety of zoo housed animals.

Analytical techniques involving a scoring system were described which gave consistent results for both preference and inelasticity rankings. The results showed that tapirs demonstrated a strong preference for having a small area aside from their usual inside quarters, where straw bedding is available to them for rest. Not only did

the animals choose this commodity, but it was also demonstrated to be the most important or inelastic commodity.

*Discussion
&
References*

Chapter Eleven

GENERAL DISCUSSION

*Discussion
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References*

Chapter Eleven

GENERAL DISCUSSION

"If an animal is not equipped to make sounds like talking, it doesn't mean it can't think. All we have to do is figure out how to make it convey its thoughts"

Alice Hopf

11.1 *Aim of Project*

The controversy surrounding zoos is vast. Opinions about zoos are often mixed and emotional. Although it is a very personal and moral decision as to whether one agrees or disagrees with the ethics of zoos, it is essentially irrelevant; the fact is, zoos exist. However, with increasing awareness both in a scientific and non scientific field, zoo managers are now making a conscious effort to improve the standard and conditions of most modern zoos. Increasing effort is being made in providing resources to various research areas, in order to improve the overall well-being and welfare of zoo animals. Through behavioural research, this project ultimately aimed to establish the needs of captive giraffes and tapirs, while also addressing fundamental behavioural and welfare issues associated with all zoo housed animals.

This project followed many steps in order to achieve these aims. The first step examined detailed activity patterns of both species by looking at their behavioural budgets both diurnally and nocturnally. Once these were obtained,

behaviours which were demonstrated to exist at lower levels in captivity than in the wild, were manipulated with the aim of increasing them. This aim was to alter the behavioural patterns of the captive giraffes and tapirs to a pattern that was similar to that observed in their wild counterparts.

11.3 When wild type patterns could not be simulated in captivity for these species, a method was devised so that the animals themselves could show us what is important to them in captivity. This method, "preference testing", enabled various commodities to be ranked for preference and inelasticity. Section 9.1 explains why it was only tapirs that were used for preference testing.

Each chapter of this project had its own discussion specifically for each area of focus. This chapter brings all the information together to provide a general discussion of this project, along with the implications of the findings and an overall conclusion of the results.

11.2 *Activity Budgets*

Quantitative activity budgets were obtained for each species both diurnally and nocturnally (see chapter 5 & 6 for a detailed examination of budgets). Both species followed some patterns similar to the wild. However, the level of occurrence for the behavioural categories remained different for both species in captivity compared to the wild. Tapirs showed very little difference in the activity budgets between the sexes and also between zoos. It is thought that very little difference occurs between the activity budgets of other tapir species in captivity either (*Seitz pers.comm.*). Unlike the tapirs, the giraffes did show differences in activity budgets both between sexes and also across enclosures. Observing differences between the

sexes in giraffes agrees with Pellew (1984b) who also found differences occurring between male and female giraffes, but disagrees with Veasy *et al.* (1996), who observed no differences between the sexes.

11.3 *Eliciting Wild Type Behaviour*

The existence of wild type behavioural patterns in captive animals is often considered to be an important indicator of optimum welfare (Heidiger 1950; Thorpe 1965,1967; Chamove 1989).

Herbivores are a species that are likely to be inhibited in a variety of ways from performing certain behaviours to the same frequency as that of their wild counterparts. In the wild large cats will tend to spend a large proportion of their day resting, for example lions *Panthera leo* can spend up to 20 hours out of 24 hours resting (Schaller 1974). Resting is a behaviour that can be performed at the same frequency as the wild in captivity.

However, if we examine herbivores, it has been demonstrated that their main activity in the wild is feeding and feeding related behaviour e.g. foraging (Bearder & Martin 1980; Harcourt & Stewart 1984; Pellew 1994). In captivity, herbivores are often grossly restricted in performing this behaviour due to lack of natural vegetation, space limitations and bulk feeding i.e. receiving all their nutritional requirements in one feed. So, if this major behaviour is been drastically reduced, other behaviours must be created or performed at a higher frequency in its absence. It is therefore not surprising that by examining the activity budgets of both the tapirs and giraffes that we find not only different levels of certain activities occurring in captivity, but also behaviours may be seen that are not exhibited in the

wild, such as grazing in giraffes. For this reason, I believe herbivores are good subjects to use when trying to alter activity budgets to wild type patterns.

Both species examined demonstrated lower levels of feeding in captivity than in the wild, so feeding experiments were provided in order to increase feeding related behaviour in the case of tapirs and feeding intake in the case of the giraffes. Since there is no actual value established as to the proportion of time wild lowland tapirs spend feeding, but there is on activity levels, the test conducted in chapter 7 aimed to increase active behaviours such as exploration (foraging) and locomotion. Feeding levels of wild giraffe are known, and so the test conducted in chapter 8 attempted to increase their feeding intake. Both species failed to increase the behaviours examined despite being given the opportunity to do so.

In the tapirs an increase in the desired behaviours were observed during the times of feeding, which was in the morning for the Dublin individuals and both morning and afternoon for the Fota individuals. Coinciding with these increases, decreases were observed in other behaviours, most notably in resting behaviours. However, examining the times outside their feeding period, increases were observed in the less active behaviours, e.g. resting and decreases in the active behaviours like exploratory behaviour and locomotion. This led to no change occurring in the total amount of time spent in each activity for the individuals overall. These results suggest that the tapirs possess very inelastic behavioural properties (see chapter 1, section 1.11), i.e. despite them being elastic as to when the behaviours occur in their activity budget, the actual amount of time spent in each behaviour is very inelastic.

The giraffes also failed to increase their feeding intake despite being provided with additional food. However, through the provision of additional browse, grazing levels did significantly decrease for all individuals, and where usual quota of browse was provided high levels of licking behaviour occurred. During

experimental conditions this behaviour reduced a great deal to levels approaching zero.

We also saw that the occurrence of browse affected the levels of other behavioural categories, which supports the idea posed in chapter 6, that the absence or presence of browse may be a defining factor in determining the activity budgets of giraffes and not enclosure type or size or group composition.

11.4 *The Search for Animals' Needs*

It is quite plausible to reason that the needs of captive animals are different to the needs from their wild counterparts. In captivity, all commodities necessary to the animals' survival are taken care of, hence in captivity new priorities for the animals come about. Chapter 1 section 1.10 discusses the changes between the needs of wild and captive individuals in depth. This study showed that both tapirs and giraffes behave differently from their wild counterparts and that neither species engaged in wild type behavioural levels in a captive environment despite being given the opportunity to do so. Therefore, the next challenge in this project was to try and establish a way that the needs of these species could be determined. "Preference testing" is a method where the preferences of animals for various resources can be tested (Hughes & Black 1973; Dawkins 1983; Cooper & Mason 2000). Mason *et al.* (1998) provided guidelines for examining preferences, however, to date all preference testing has been done on farmed and laboratory animals only. These conditions often are more stringent and can be manipulated so as to adhere to the guidelines. However, in the case of zoo animals, due to constraints such as

husbandry regimes etc., although these guidelines can be of use they can only be followed loosely and so new guidelines must be established for zoo housed animals, (see Chapter 9).

In this study preference testing was conducted only on the tapirs, (for reasons explained in chapter 9). However, a method was devised which could be utilised for testing and analysing preferences in many captive animals. Preference testing asks the animals themselves what they want, but by also analysing inelasticities we can also discover, not just what they want but what is truly necessary and important for these animals. The study did in fact prove to be successful and provided information on the ranked preferences of tapirs in captivity.

11.5 *Implications of Study*

This study has demonstrated that captive giraffe and tapirs do not behave like that of their wild counterparts. By examining the ecology of herbivores in the wild, it is highly likely that all herbivores in captivity behave differently from those in the wild.

Although in the wild tapirs may be considered to be more adaptable (due to their ability to browse and graze) than giraffes (who are exclusive browsers), in captivity, tapirs appear to have greater inelastic properties than giraffes. They showed very little variation in activity budgets across groups and sexes, whereas the giraffes showed great variation between sexes and enclosures. This reiterates the importance of conducting in depth behavioural analysis on the captive species before making assumptions based solely on wild type ecology.

in capt This study has also shown that aiming to make captive species exhibit wild type behaviour may not be desirable in an environment which is lacking in so many variables which occur in the wild and that their needs are different in captivity. By forcing them into wild type behaviour in captivity we may actually be reducing the welfare of these animals and not improving it as is intended.

recap Many enrichment studies are aimed at increasing feeding related behaviour. The preferences of tapirs showed that additional food was not the most preferred or important commodity. What was found i.e. a separate sleeping quarter away from their main quarter, was totally unexpected and was found to be ranked extremely important to them, for all individuals examined. This again shows the importance of in depth behavioural analysis, particularly before providing enrichment to the animals. By aiming enrichment at behaviours that are assumed to be important to the animals, rather than those which are proven to be important, the enrichment may not actually cause harm to the animals, but it may not have any benefit at all and hence is fruitless. In order to make enrichment invaluable to zoo environments and to improve captive animal welfare, preference testing can be used to establish the important behaviours or commodities and hence they can be enriched accordingly.

school By no means am I implying that food is not important to the animals, but by providing the animals with all their nutritional requirement in one bulk feed, other behaviours become more important to them. In the wild, food and the search for food is the primary survival tool for animals. In captivity, this primary survival necessity is removed along with other survival issues such as predator evasion, mate searching and territoriality. Once these main survival needs are removed in captivity, this leaves the animals with time to fulfil other needs, which may not be the case in the wild. For instance, if an animal has obtained sufficient nutrients in its daily feed

in captivity, there is no longer any need for it to extend its feeding time, so why aim enrichment at feeding related behaviours? However, we must be careful that the process of feeding is not solely for nutritional intake. Feeding may have an additional function, as in the case of giraffes. The results presented in chapters 6 and 8, may be argued to suggest that in addition to obtaining nutrients, giraffes receive oral stimulation from feeding, especially as they do in the wild when they obtain browse from thorny *acacia* trees. So, despite quickly receiving their nutritional intake in captivity, giraffes also need some form of oral stimulation, similar to the levels they obtain in the wild. This can be provided either in a naturalistic way, providing them with sufficient browse, or in an "unnaturalistic" way, as often observed in captive giraffe, i.e. the licking of inanimate objects.

As discussed in chapter 1, section 1.9, Lindburg (1988) has shown that in the wild large cats will refrain from hunting if scavenging becomes an available option to them. Something similar can be seen in captive animals. Herbivores in the wild must spend a large proportion of their activity budget feeding, this is due to the low nutritional content of plants. Plants are abundant in carbohydrates such as sugars and starches but are low in fat and protein, which are essential for the growth and repair of body tissues (Janis & Jarman 1984), hence they must feed for long periods to meet their necessary daily requirements. Tapirs appear to avail of this extra time in captivity by increasing resting periods and giraffes by tongue playing, grazing and oral manipulation. Since the new time available in the activity budgets of captive herbivore species is so great, and since the time left in wild herbivore species' activity budgets is so little after feeding, it is not surprising when in captive environments, herbivore species demonstrate behaviours that are vastly more frequent or behaviours that may not be seen in the wild. This same reasoning can be applied across all species, for example, in the absence of hunting for food and being

supplied with a readily available food source, carnivores may increase resting behaviours or produce stereotypies.

If the welfare of the animals is examined, the wild environment is a harsh, dangerous and difficult environment to survive in, regardless of whether the hardships encountered by wild species are as a result of human intervention such as poaching or habitat destruction, or natural occurrences such as disease parasites or starvation. In captivity all these adversities are removed and the animals are provided with the necessary resources to survive and are left to utilise their activity budgets with "luxury" behaviours. By this reasoning, it could appear that captive environments provide greatly for the welfare of the animals and hence, could be considered optimum welfare conditions. The tapirs for example demonstrated extremely inelastic behavioural properties, perhaps suggesting that they are behaving optimally for their present environment despite it being different to their wild behavioural patterns. Giraffes also may adapt optimally to their environments, by tongue manipulation and oral manipulation. Although reduced greatly in the presence of plentiful browse, the occurrence of these behaviours in the absence of sufficient browse does not necessarily mean that their welfare was compromised, but could mean that they have adapted to the current environment. However, it can be argued that although their welfare might be adequate in captivity the conditions are "unnatural".

Wild type behaviours may not be optimal behavioural patterns for many captive animals and by forcing the animals to behave as such may actually jeopardise their welfare. However, the importance of such wild type behaviour patterns for endangered or reintroduced species can not be denied. These species need the necessary tools for survival if their species are to be saved, and one must advocate the importance of maintaining wild type behaviours in these group of animals.

However, a dilemma occurs when species such as tapirs and giraffes, which are not currently endangered or on reintroduction programmes are being examined. If the view that wild type behaviour is not optimal for captive animals and that, in the absence of wild type conditions the animals will have different needs depending on the environment, do we allow for these needs, or do we potentially jeopardise the welfare of these animals now, just in case we need to save these species in the future?

I suggest that this dilemma cannot be resolved and that the ultimate aim for the particular species must be deeply considered when carrying out future research in zoo housed animals.

11.6 *Husbandry Recommendations*

Based on the results of this study I have the following recommendations regarding the requirements of tapirs and giraffes in captivity:-

TAPIRS

- (i) 24 hour access to their outside paddock all year round.

Both Fota and Dublin tapirs were allowed 24 hour access to their outside enclosure. Tapirs showed some activity occurring after zoo opening hours and nocturnally. Furthermore, tapirs can be quite aggressive to one another particularly close to parturition (Lee 1994a). Having 24 hour access will enable the individuals to flee aggressive encounters preventing possible physical damage.

- (ii) Multiple feeds daily, at least two, from unpredictable numerous feeding stations.

Although no overall all change was observed diurnally, the hours of feeding did show significant increases in their activity levels. Breaking the feeding into two or more times a day and feeding from multiple stations would break up the long bouts of resting observed in the Dublin individuals diurnally. This would be beneficial to the tapirs by increasing activity which would encourage them to feed in a more natural method and hence, to some extent would encourage more wild type behaviour without jeopardising their welfare. Furthermore, this would also benefit visitors to the zoo. By providing them with an opportunity to see the tapirs active and not just sleeping (which they tend to do at peak visiting times), hence, public interest in tapirs would rise. This may have beneficial knock-on effects for conservation at this crucial time for these species, when they are currently threatened in the wild.

- (iii) A separate area with straw bedding from their usual inside enclosure.

After conducting preference tests on these species, I believe this to be one of the most important recommendations for the welfare of captive tapirs. The idea of a sleeping quarter separate to where they are fed and defecate, is one which has not been documented before. Both groups of tapirs tested demonstrated a high ranked

preference for such a room and demonstrated this commodity to be very inelastic. In addition to these preferences the separate area also has many functional uses. The area can act as a place where the tapirs can be cornered and can receive veterinary treatment more easily. Probably more importantly, this area can provide a safe secure nesting area for the female and a newborn which can be out of the public's view during very early stages preventing any distress. Furthermore it is an additional area where the individuals can be separated should they need to be. I am happy to record that Dublin has decided to leave this area available to the tapirs, and Fota are currently building a new enclosure and have decided to include a separate area in their new indoor enclosure for the tapirs.

GIRAFFES

- (i) Provide as much browse as possible ensuring there are more piles than animals so preventing any individual being excluded due to dominance

Providing the giraffes with plenty of browse has been demonstrated to reduce tongue playing and licking behaviour. Ensuring there are enough browse piles for all individuals, ensures that no one individual will be excluded from browsing due to a dominance hierarchy, as occurred in the Dublin individuals. Providing the giraffes with browse at more than one interval a day I feel would make a large impact on their behavioural budgets, as has been demonstrated in chapter 8.

- (ii) If large quantities of browse are not available, provide the giraffes a challenging way in which they must utilise their tongues to manipulate access to food.

In the absence of sufficient browse, effort should be made to provide the giraffes with oral stimulation. This could be done by hiding bits of fruit in log holes, or intertwining browse and hay through meshes making it difficult for the individuals to obtain food. This would provide them not only with oral stimulation but would also discourage the animals from licking poles or walls which could have substances on them which could cause harm to the giraffes, such as paint and rust.

11.7 *Future Advances*

This study has highlighted areas where further research would be valuable to explore these various theories and ideas more. Some possible advances on these are:

- (i) To conduct the feeding experiment on tapirs with a limited time budget in order to examine the inelastic behavioural properties further and try to find a differentiation between the inelastic properties of the different behaviours. By providing the individuals with a limited time to perform various behaviours such as feeding, foraging etc., the individuals would be forced to reduce or eliminate

some behaviours in preference for others. This would then inform as to which behaviours were more important than others.

- (ii) Manipulate the nutritional intake of the species being tested to see how the various behaviours examined alter with varying nutritional consumption.
- (iii) Examine the relationship between tongue playing and oral manipulation and feeding in giraffes.
- (iv) Test a variety of methods which could provide oral stimulation for giraffes in the absence of fresh browse, particularly in the winter.
- (v) Conduct preference testing on various other species, particularly with a species whose wild type behaviour is well documented.
- (vi) Using the same methodology and analysis conduct preference testing using different costs such as increasing the weight of the flaps and a greater variety of commodities, such as digging for food.

11.8 Conclusion

In Chapter 1, section 1.14 various behavioural and welfare questions were posed to provide insight into the needs of captive animals, with particular reference to lowland tapirs and giraffes. Now, these questions will be re-examined and the degree to which they have been answered -:

- (i) **How do both species behave over a 24 hour period?**

Chapter 5 and 6 provide an in depth evaluation of the tapirs' and giraffes' activity

budgets. Tapirs demonstrated very little difference in activity budgets between sexes and across different groups and enclosures. Giraffes on the other hand did show variation between the activity budgets of the different sexes and across enclosures.

(ii) Are the activity budgets similar to those of their wild counterparts?

Neither the tapirs nor the giraffes behaved in the same way as their wild counterparts. For reasons explained above it is also unlikely that any large herbivore species will behave the same as observed in the wild. Furthermore, due to the huge difference between wild and captive environments, it is plausible to reason that most captive species will in fact behave differently from their wild counterparts.

(iii) Can a wild type activity pattern be elicited in a captive environment?

Neither species increased desired behaviours to wild levels despite being given the opportunity to do so, however, certain behaviours were increased, leaning towards wild type patterns. Since both species are herbivores both tests encouraged wild type behaviours through feeding related experiments. Manipulating nutritional intake may have produced different results but was not possible for this study. I see no reason to try to recreate wild type behavioural patterns in a captive environment for species which are not endangered or on a reintroduction program. This is particularly important if the animals are demonstrating different needs relating to their captive condition than would be present in the wild.

(iv) **What are the behavioural properties of tapirs and giraffes and do they change with environment?**

Tapirs exhibited extremely inelastic behavioural properties. While their activity budgets themselves appeared to be elastic, the actual time spent in each behaviour over a day was very inelastic. Furthermore, very little difference occurred between sexes and different environments. Giraffes appeared to have greater elasticity within their activity budget, altering the amount of time spent in various activities both between sexes and in different environments.

(v) **Can preference testing be conducted successfully in a zoo environment?**

Yes, by following certain guidelines as described in Chapters 9 and 10, preference testing can be conducted and analysed successfully in a zoo environment.

(vi) **Do the animals demonstrate preferences for different commodities?**

The tapirs demonstrated a ranked preference between the commodities, showing the highest ranked preference for an area with straw which was separate from their main enclosure.

In conclusion, I believe that this study has gone some way towards answering the questions posed and has achieved the aims presented at the beginning of this project. This project has also managed to bring captive animals into the stringent and important world of preference testing by successfully conducting preference testing for the first time on a zoo housed species. Finally, this project has opened up many areas of discussion which are of the utmost importance to the welfare of all captive species.

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Appendices

Appendix 1a :

EXAMPLE OF TAPIR CHECKSHEET

Date:

Tapirs

Exp:

Time:

FEEDING

Season

tm	area		prox	rest		sd		graz		browse		straw		other		loco		explore		sexual		agg		other		Interactions			
	m	f		m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f	m	f		
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Appendix 16:

EXAMPLE OF GIRAFFE CHECKSHEET

Date:

Season:

Exp:

Tm	Feeding									Rumination									Licking	T. Play	Sex	Other	Interact													
	Browse			Graze			Other			Forage			Stand			Loco								Ly Stand			Loco			Ly						
	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2	m	f1	f2
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*Appendix 2a:*TAPIR ETHOGRAM

<u>Behaviour</u> <i>Abbreviation</i>	<u>Description</u>
FEEDING: <i>Feed</i>	Actual ingestion of any food substance
STANDING: <i>Std</i>	Standing whilst engaging in no other activity of any sort
RESTING: <i>Rest</i>	Sitting or lying down, both with eyes open and shut, engaging in no other activity
LOCOMOTION: <i>Loco</i>	Walking or running about the paddock, moving from one place to another
EXPLORATORY: <i>Explor</i>	Either stationary or while moving the sniffing of the ground and/or their environment
SEXUAL ACTIVITY: <i>Sex.Act</i>	Any form of sexual activity, such as sniffing of genitalia, flehmen; attempted mounting, copulation
AGRESSION: <i>Agg</i>	Any aggressive act, such as biting, nipping; chasing and head butting
OTHER: <i>Oth</i>	Any other behaviour not preciously described, such as drinking, scratching, play etc.

*Appendix 26:***GIRAFFE ETHOGRAM**

<u>Behaviour</u> <i>Abbreviation</i>	<u>Description</u>
FEEDING: <i>Feed</i>	The actual ingestion of any food item
FORAGING: <i>Forage</i>	Either standing or walking with head lowered examining ground
STANDING: <i>Std</i>	Standing while performing no other activity
LOCOMOTION: <i>Loco</i>	Walking around the enclosure while performing no other activity
REST:	Either lying down with eyes open and head erect or lying down with head on flank with eyes shut
RUMINATION: <i>Rumin</i>	The chewing of regurgitated undigested food, "chewing the cud"
LICKING: <i>Lick</i>	The licking of inanimate objects such as walls, poles and gates
TONGUE PLAYING: <i>T.Play</i>	Manipulating the tongue in tongue rolling or flipping, also includes playing with straw or grass blades with the tongue
SEXUAL ACTIVITY: <i>Sex.Act</i>	Any form of sexual activity such as flehmen, sniffing genitals, attempted mounting or mounting
SPARRING: <i>Sparr</i>	Head butting another individual or intertwining necks
OTHER: <i>Oth</i>	Any other behaviour not previously described

Appendix 3:

Post Hoc Results: Giraffe Activity Budgets

Individual	Behaviours	Critical Differences		
		E1-E2	E1-E3	E2-E3
MALE	Feeding	NS	NS	NS
	Foraging	NS	NS	NS
	Standing	38.06*	12.73	25.33*
	Locomotion	24.3*	9.7	34.55*
	Rumination	18.25*	24.8*	6.55
	Licking	10.8	27.92*	38.74*
	Tongue Play	28.05*	48.3*	20.28*
	Sexual Activity	24.45*	15.1	9.35
	Sparring	18.17*	2.83	15.34*
	Other	2.37	19.17*	16.89*
F1 FEMALE	Feeding	24.78*	10.62	14.16
	Foraging	16.23*	1.41	14.83
	Standing	33.79*	7.78	41.57*
	Locomotion	37.58*	9.07	27.52*
	Rumination	3.35	16.25*	12.7
	Licking	11.83	30.58*	42.41*
	Tongue Play	9.17	31.43*	22.21*
	Sexual Activity	NS	NS	NS
	Sparring	NS	NS	NS
	Other	12.24	16.77*	4.53
F2 FEMALE	Feeding	2.28	20.67*	17.43*
	Foraging	22.25*	10.1	12.15
	Standing	26.41*	16.23*	14.18*
	Locomotion	41.87*	13.93	27.94*
	Rumination	25.15*	12.1	13.05
	Licking	9.34	29.23*	38.57*
	Tongue Play	11.7	24.3*	12.6
	Sexual Activity	NS	NS	NS
	Sparring	18.88*	0.037	16.51*
	Other	20.85*	8.73	12.5
Critical Value= 16.14		N=30,30,30		
* = Significant at P<0.05				
NS= No significant difference found between the enclosures using Krukall Wallis analysis				

Table 6.1: Table showing the critical differences occurring between the enclosures for each individual as obtained by Post Hoc analysis

Behaviours	Critical Differences		
	M-F1	M-F2	F1-F2
Feeding	NS	NS	NS
Foraging	NS	NS	NS
Standing	10.63*	11.36*	0.73
Locomotion	NS	NS	NS
Lying	3.3	11.27*	7.94*
Sleeping	1.2	9.7*	8.5*
Rumination	NS	NS	NS
Licking	NS	NS	NS
Tongue Play	NS	NS	NS
Sexual Activity	6.86*	7.63*	1.37
Sparring	NS	NS	NS
Other	12.3*	5.3	6.7
Unknown	20.1*	3.8	16.3*

Table 6.2: Table showing the critical differences occurring between the individuals for each enclosure as obtained by Post Hoc analysis

Enclosure	Behaviours	Critical Differences		
		M-F1	M-F2	F1-F2
1 Indoors	Feeding	NS	NS	NS
	Foraging	NS	NS	NS
	Standing	NS	NS	NS
	Locomotion	32.75*	34.95*	1.2
	Rumination	17.48*	8.86	8.62
	Licking	7.02	31.27*	24.29*
	Tongue Play	42.07*	35.33*	6.74*
	Sexual Activity	14.89	17.27*	2.38
	Sparring	NS	NS	NS
	Other	21.08*	10.57	10.51
2 Outside Old	Feeding	NS	NS	NS
	Foraging	14.5	17.54*	3.88
	Standing	7.89	15.33	23.22*
	Locomotion	NS	NS	NS
	Rumination	NS	NS	NS
	Licking	3.01	13.57	16.58*
	Tongue Play	33.46*	22.88*	10.58
	Sexual Activity	36.35*	36.42*	0.18
	Sparring	NS	NS	NS
	Other	20.9*	14.5	35.4
3 African Plains	Feeding	NS	NS	NS
	Foraging	NS	NS	NS
	Standing	NS	NS	NS
	Locomotion	18.38*	16.66*	2.18
	Rumination	NS	NS	NS
	Licking	NS	NS	NS
	Tongue Play	23.98*	11.27	12.71
	Sexual Activity	25.02*	25.2*	0.18
	Sparring	NS	NS	NS
	Other	9.6	15.85*	25.45*
Critical Value= 16.14		N=30,30,30		
* = Significant at P<0.05				
NS= No significant difference found between the individuals using Krukall Wallis analysis				

Table 6.3: Table showing the critical differences and their significances occurring between the individuals in each enclosure as obtained by Post Hoc analysis

Appendix 5a

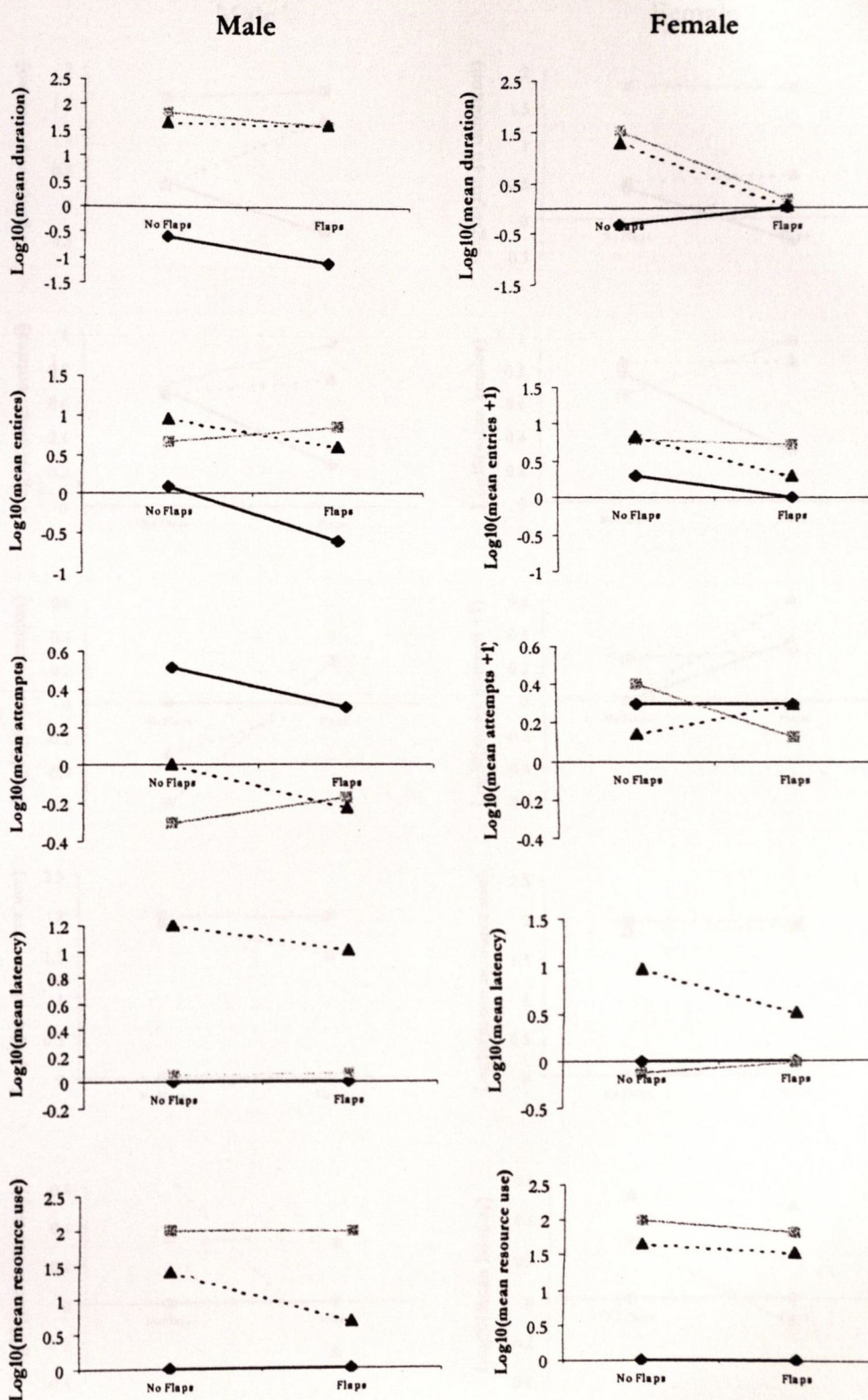


Fig 10.2a: Graph showing a the slopes of each commodity for the male and female tapirs under each at Dublin

— = Bare - - - = Straw = Browse

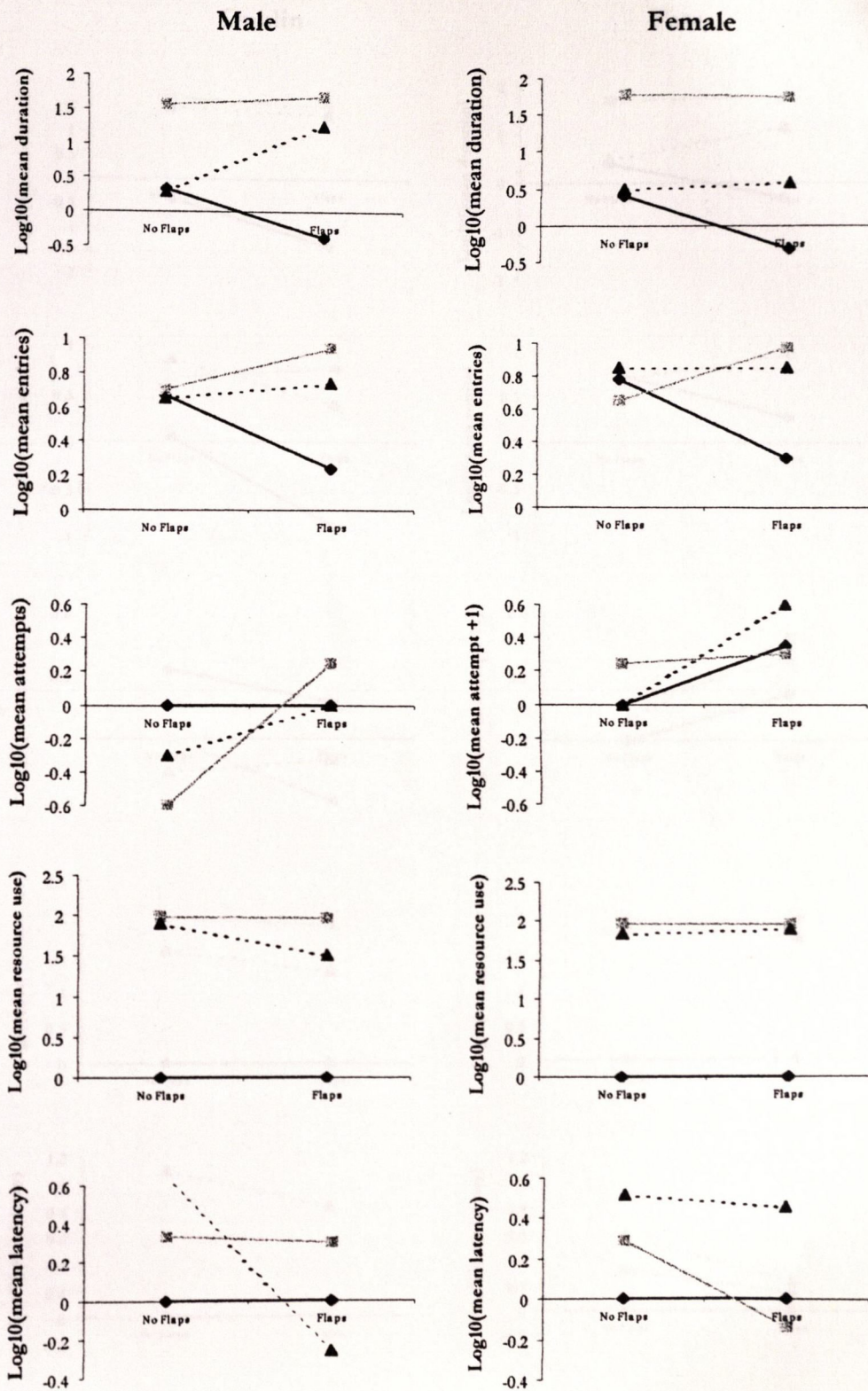


Fig 10.2b: Graph showing the slopes of each commodity for the male and female tapirs under each at Fota

———— = Bare - - - - - = Straw = Browse

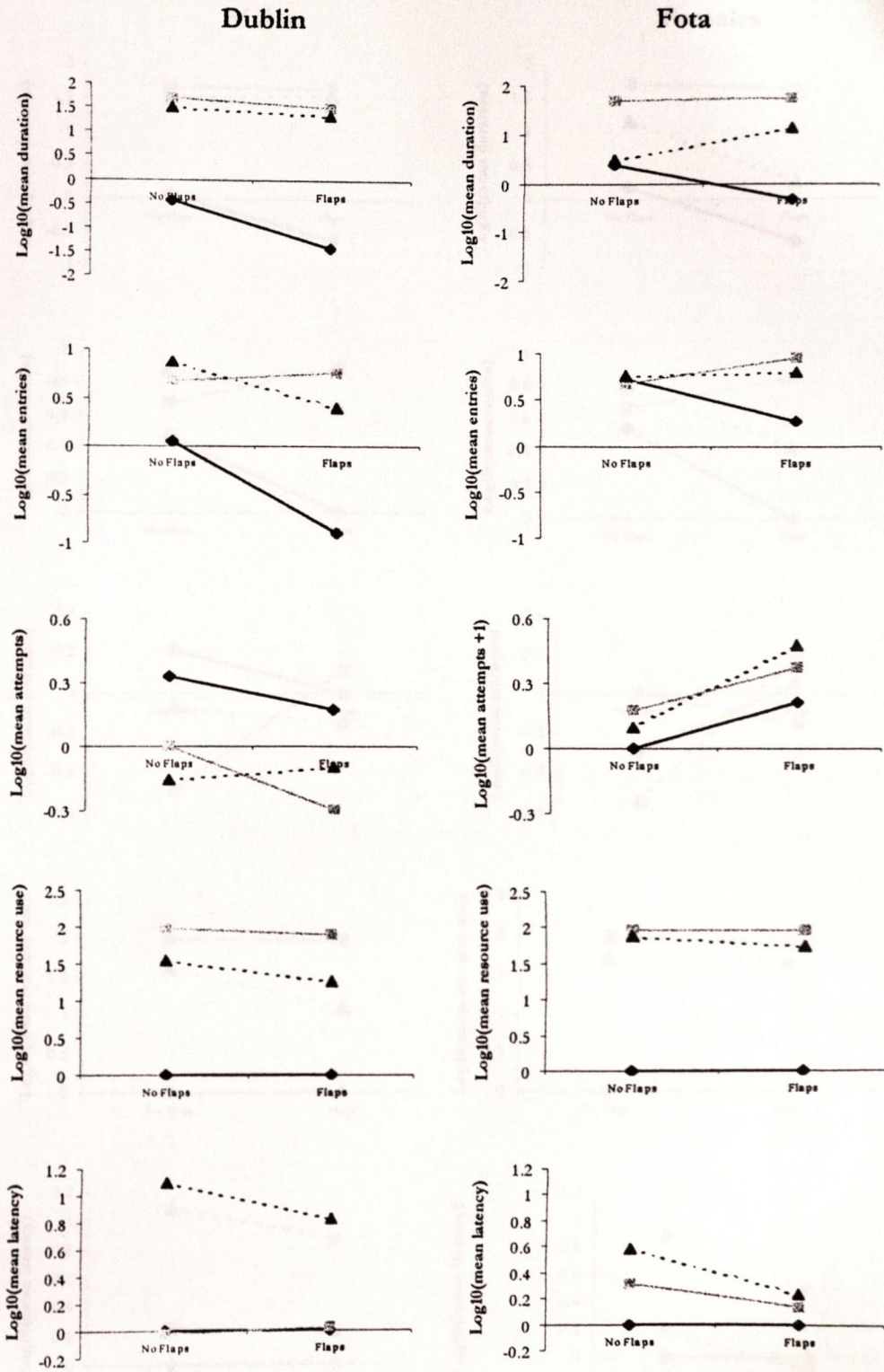


Fig 10.2c: Graph showing a comparison between the slopes of each commodity for the Dublin and Fota individuals

———— = Bare - - - - - = Straw = Browse

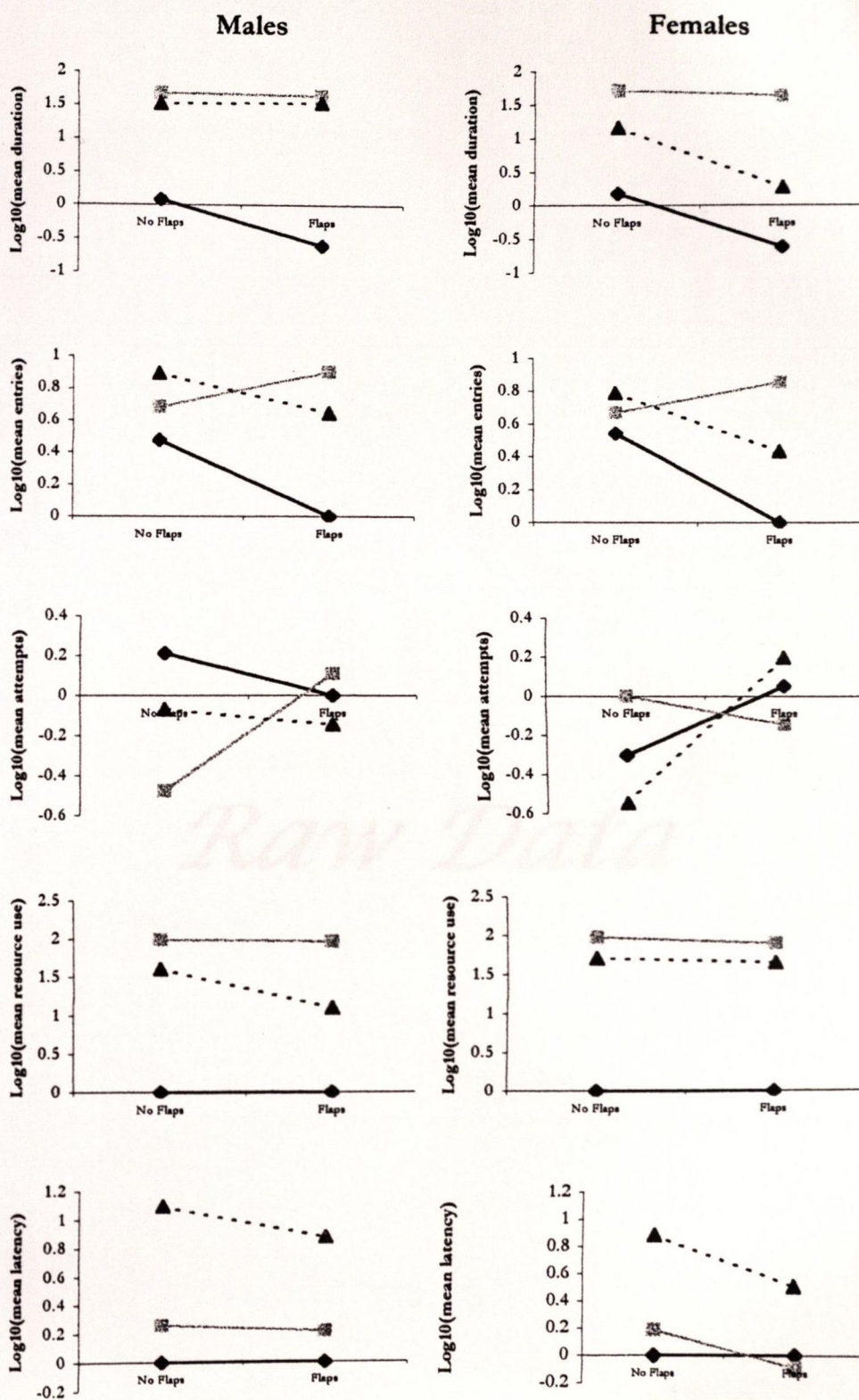


Fig 10.2d: Graph showing a comparison between the slopes of each commodity for the males and females pooled from each zoo

———— = Bare - - - - - = Straw = Browse

Raw Data

Dublin and Fota Activity Budgets

Zoo	Time	Individ	Feed	Std	Rest	Loco	Explore	Sex	Agg	Other	Proxy	Indoors	Season	Morn/After
1.00	1.00	1.00	16.70	3.30	78.30	.00	.00	.00	.00	1.70	97.00	100.00	1.00	1.00
1.00	1.00	1.00	5.00	6.70	76.10	6.70	3.00	.00	.00	2.50	47.80	100.00	1.00	1.00
1.00	1.00	1.00	33.30	.00	61.70	.00	.00	.00	.00	5.00	.00	100.00	1.00	1.00
1.00	1.00	1.00	10.00	3.30	81.70	1.70	.00	.00	.00	3.30	85.00	100.00	1.00	1.00
1.00	1.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	1.00	10.00	15.00	65.00	5.00	.00	3.30	.00	1.70	28.30	96.67	1.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	98.30	1.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	5.00	100.00	1.00	1.00
1.00	3.00	1.00	19.30	3.50	73.80	3.50	.00	.00	.00	.00	23.30	100.00	1.00	1.00
1.00	3.00	1.00	8.40	11.70	73.30	3.30	.00	.00	.00	3.30	38.60	100.00	1.00	1.00
1.00	4.00	1.00	28.00	8.80	45.60	8.80	3.30	.00	.00	5.40	13.40	75.40	1.00	2.00
1.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	1.00	2.00
1.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	33.40	100.00	1.00	2.00
1.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	21.10	100.00	1.00	2.00
1.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	11.70	100.00	1.00	2.00
1.00	5.00	1.00	54.10	1.60	31.40	9.80	.00	.00	.00	3.30	39.20	100.00	1.00	2.00
1.00	5.00	1.00	33.20	.00	21.60	15.00	3.30	8.30	.00	18.30	40.00	100.00	1.00	2.00
1.00	5.00	1.00	43.30	11.70	.00	15.00	5.00	11.70	.00	13.30	46.60	100.00	1.00	2.00
1.00	5.00	1.00	44.00	16.00	.00	6.00	.00	.00	.00	33.90	58.30	90.00	1.00	2.00
1.00	5.00	1.00	30.10	38.30	.00	13.30	.00	3.30	.00	15.00	19.70	83.30	1.00	2.00
1.00	6.00	1.00	16.60	18.30	33.40	15.00	3.30	3.30	.00	10.00	60.00	100.00	1.00	2.00
1.00	6.00	1.00	37.90	13.80	22.70	5.20	.00	.00	.00	20.40	28.30	100.00	1.00	2.00
1.00	6.00	1.00	35.00	1.70	60.00	.00	.00	.00	.00	3.30	28.30	100.00	1.00	2.00
1.00	6.00	1.00	20.10	18.30	.00	31.70	.00	3.30	.00	26.70	16.70	100.00	1.00	2.00
1.00	6.00	1.00	60.00	31.70	.00	3.30	3.30	.00	.00	1.70	43.40	80.00	1.00	2.00
1.00	7.00	1.00	66.70	16.70	.00	10.00	1.70	1.70	.00	3.30	52.80	94.00	1.00	2.00
1.00	7.00	1.00	64.60	17.60	.00	10.40	4.20	.00	.00	3.20	66.70	85.00	1.00	2.00
1.00	7.00	1.00	63.60	12.30	.00	18.20	5.00	.00	.00	1.70	44.70	100.00	1.00	2.00

1.00	7.00	1.00	60.00	18.40	.00	12.00	3.30	1.70	.00	5.00	45.00	100.00	1.00	2.00
1.00	7.00	1.00	55.00	10.00	20.00	15.00	.00	.00	.00	.00	55.00	78.00	1.00	2.00
1.00	1.00	2.00	5.00	.00	92.00	.00	3.30	.00	.00	.00	97.00	100.00	1.00	1.00
1.00	1.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	47.80	100.00	1.00	1.00
1.00	1.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	1.00	1.00
1.00	1.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	85.00	100.00	1.00	1.00
1.00	1.00	2.00	6.70	3.30	92.00	1.70	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	2.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	28.30	91.40	1.00	1.00
1.00	3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	1.00
1.00	3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	5.00	100.00	1.00	1.00
1.00	3.00	2.00	45.00	11.70	43.00	.00	.00	.00	.00	.00	23.30	100.00	1.00	1.00
1.00	3.00	2.00	26.30	14.00	43.80	10.50	3.30	.00	.00	1.70	38.60	100.00	1.00	1.00
1.00	4.00	2.00	25.00	.00	75.00	.00	.00	.00	.00	.00	13.40	100.00	1.00	2.00
1.00	4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	1.00	2.00
1.00	4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	33.40	100.00	1.00	2.00
1.00	4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	21.10	100.00	1.00	2.00
1.00	4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	11.70	76.70	1.00	2.00
1.00	5.00	2.00	76.70	15.00	.00	8.30	.00	.00	.00	.00	39.20	100.00	1.00	2.00
1.00	5.00	2.00	26.20	16.40	34.00	1.60	8.00	.00	.00	11.70	40.00	100.00	1.00	2.00
1.00	5.00	2.00	36.70	21.70	.00	6.70	3.30	1.70	.00	30.00	46.60	85.00	1.00	2.00
1.00	5.00	2.00	50.80	29.50	.00	8.20	.00	.00	.00	8.30	58.30	95.00	1.00	2.00
1.00	5.00	2.00	49.00	25.50	.00	13.70	.00	.00	.00	5.90	19.70	83.60	1.00	2.00
1.00	6.00	2.00	65.00	6.70	12.00	8.30	.00	.00	.00	3.30	60.00	100.00	1.00	2.00
1.00	6.00	2.00	55.40	7.10	.00	16.10	5.00	10.00	.00	3.00	28.30	100.00	1.00	2.00
1.00	6.00	2.00	40.00	11.70	42.00	.00	6.70	.00	.00	.00	28.30	100.00	1.00	2.00
1.00	6.00	2.00	65.50	5.80	.00	5.80	10.50	.00	.00	13.40	16.70	100.00	1.00	2.00
1.00	6.00	2.00	60.00	13.30	.00	18.30	5.00	.00	.00	1.70	43.40	100.00	1.00	2.00
1.00	7.00	2.00	68.70	13.30	.00	8.30	3.00	2.00	.00	4.70	52.80	78.30	1.00	2.00
1.00	7.00	2.00	29.50	23.00	31.00	9.40	4.60	.00	.00	1.70	66.70	100.00	1.00	2.00
1.00	7.00	2.00	70.00	9.10	.00	14.50	.00	.00	.00	6.40	44.70	100.00	1.00	2.00
1.00	7.00	2.00	55.00	12.70	12.00	9.00	6.70	.00	.00	4.60	45.00	89.00	1.00	2.00

1.00	1.00	1.00	33.30	5.80	54.20	3.30	2.50	.00	.00	.80	85.00	100.00	2.00	1.00
1.00	1.00	1.00	.00	44.20	55.80	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	1.00	1.00	17.50	59.20	20.00	.80	1.70	.00	.00	.80	87.50	100.00	2.00	1.00
1.00	1.00	1.00	2.00	7.00	84.00	1.00	6.00	.00	.00	.00	2.00	100.00	2.00	1.00
1.00	2.00	1.00	.00	1.70	95.80	1.70	.80	.00	.00	.00	25.00	100.00	2.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	2.00	1.00
1.00	3.00	1.00	30.00	6.50	47.70	4.70	5.60	.00	.00	5.60	51.40	100.00	2.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	3.00	1.00	8.30	.00	83.30	8.30	.00	.00	.00	.00	83.30	83.30	2.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	2.00	1.00
1.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
1.00	4.00	1.00	21.70	26.70	38.30	11.70	1.70	.00	.00	.00	21.70	46.70	2.00	2.00
1.00	4.00	1.00	20.80	10.80	40.80	15.80	10.00	.80	.00	.80	55.00	46.70	2.00	2.00
1.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
1.00	4.00	1.00	25.00	24.00	42.00	6.00	2.20	.00	.00	.80	40.00	43.00	2.00	2.00
1.00	4.00	1.00	19.00	30.00	47.00	4.00	.00	.00	.00	.00	70.00	60.00	2.00	2.00
1.00	5.00	1.00	.00	5.80	68.30	2.50	1.70	8.30	.00	13.30	90.80	100.00	2.00	2.00
1.00	5.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
1.00	5.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
1.00	5.00	1.00	5.80	9.20	70.80	2.50	8.30	.00	.00	3.30	34.20	100.00	2.00	2.00
1.00	5.00	1.00	11.00	24.00	38.00	14.00	12.00	1.00	.00	.00	17.00	52.00	2.00	2.00
1.00	6.00	1.00	16.70	10.00	50.00	15.00	6.70	1.70	.00	.00	56.70	50.00	2.00	2.00
1.00	6.00	1.00	5.80	3.30	87.50	3.30	.00	.00	.00	.00	87.50	93.30	2.00	2.00
1.00	6.00	1.00	30.80	8.30	35.00	6.70	15.00	.00	.00	3.30	59.20	50.00	2.00	2.00
1.00	6.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
1.00	6.00	1.00	3.30	1.70	83.30	1.70	8.30	.00	.00	1.70	.00	96.70	2.00	2.00
1.00	7.00	1.00	60.00	16.70	.00	10.00	12.50	.00	.00	.80	13.30	20.00	2.00	2.00
1.00	7.00	1.00	47.50	40.00	.00	7.50	5.00	.00	.00	.00	11.70	40.00	2.00	2.00
1.00	7.00	1.00	30.00	56.70	.00	8.40	1.70	.00	3.30	.00	11.70	100.00	2.00	2.00
1.00	7.00	1.00	37.00	7.00	26.00	15.00	13.00	1.00	.00	1.00	9.00	48.00	2.00	2.00
1.00	7.00	1.00	53.00	21.00	.00	11.00	14.00	1.00	.00	.00	50.00	20.00	2.00	2.00
1.00	1.00	2.00	.00	.80	99.20	.00	.00	.00	.00	.00	.00	100.00	2.00	1.00
1.00	1.00	2.00	21.70	2.50	72.50	.00	3.30	.00	.00	.00	85.00	100.00	2.00	1.00

2.00	1.00	1.00	9.00	.00	81.00	6.00	4.00	.00	.00	.00	100.00	90.00	2.00	1.00
2.00	1.00	1.00	6.00	2.00	88.00	1.00	3.00	.00	.00	.00	88.00	85.00	2.00	1.00
2.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	.00	2.00	1.00
2.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
2.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
2.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	2.00	1.00
2.00	2.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	.00	2.00	1.00
2.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	.00	2.00	1.00
2.00	3.00	1.00	.00	14.00	84.00	2.00	2.00	.00	.00	.00	99.00	100.00	2.00	1.00
2.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
2.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	6.00	100.00	2.00	1.00
2.00	3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
2.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	.00	2.00	2.00
2.00	4.00	1.00	1.00	4.00	91.00	.00	3.00	.00	1.00	.00	91.00	100.00	2.00	2.00
2.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
2.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	2.00	2.00
2.00	4.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
2.00	5.00	1.00	19.00	1.00	72.00	.00	2.00	.00	.00	6.00	100.00	5.00	2.00	2.00
2.00	5.00	1.00	.00	.00	99.00	1.00	.00	.00	.00	.00	94.00	100.00	2.00	2.00
2.00	5.00	1.00	49.00	2.00	32.00	12.00	4.00	.00	.00	1.00	54.00	34.00	2.00	2.00
2.00	5.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	.00	100.00	2.00	2.00
2.00	5.00	1.00	15.00	.00	83.00	2.00	.00	.00	.00	.00	43.00	80.00	2.00	2.00
2.00	6.00	1.00	3.00	3.00	75.00	10.00	7.00	.00	.00	2.00	18.00	.00	2.00	2.00
2.00	6.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	2.00
2.00	6.00	1.00	26.00	13.00	.00	41.00	16.00	.00	.00	4.00	34.00	13.00	2.00	2.00
2.00	6.00	1.00	8.00	.00	88.00	3.00	1.00	.00	.00	.00	20.00	89.00	2.00	2.00
2.00	6.00	1.00	.00	.00	91.00	7.00	2.00	.00	.00	.00	56.00	63.00	2.00	2.00
2.00	7.00	1.00	43.00	3.00	54.00	4.00	.00	.00	.00	.00	21.00	.00	2.00	2.00
2.00	7.00	1.00	42.00	9.00	39.00	9.00	1.00	.00	.00	.00	41.00	50.00	2.00	2.00
2.00	7.00	1.00	3.00	5.00	52.00	35.00	4.00	.00	.00	1.00	72.00	53.00	2.00	2.00
2.00	7.00	1.00	46.00	4.00	16.00	30.00	1.00	.00	.00	3.00	68.00	22.00	2.00	2.00
2.00	7.00	1.00	42.00	4.00	35.00	16.00	3.00	.00	.00	.00	59.00	48.00	2.00	2.00
2.00	1.00	2.00	33.00	29.00	7.00	20.00	5.00	.00	.00	6.00	51.00	43.00	2.00	1.00
2.00	1.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	2.00	1.00
2.00	1.00	2.00	7.00	4.00	83.00	9.00	.00	.00	.00	.00	100.00	88.00	2.00	1.00
2.00	1.00	2.00	5.00	3.00	87.00	2.00	3.00	.00	.00	.00	87.00	84.00	2.00	1.00

1.00	20.00	2.00	5.00	10.00	85.00	.00	.00	.00	.00	.00	100.00	70.00	1.00	3.00
1.00	21.00	2.00	32.50	24.20	27.00	5.80	3.30	1.70	.00	5.50	59.00	65.00	1.00	3.00
1.00	21.00	2.00	33.30	16.70	17.00	16.70	6.70	3.30	.00	6.30	38.00	100.00	1.00	3.00
1.00	21.00	2.00	43.80	28.30	.00	20.00	.00	.00	.00	8.00	50.00	100.00	1.00	3.00
1.00	21.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	52.80	100.00	1.00	3.00
1.00	21.00	2.00	37.00	25.00	28.00	10.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	22.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	22.00	2.00	.00	5.00	85.00	5.00	3.30	.00	.00	1.70	97.00	100.00	1.00	3.00
1.00	22.00	2.00	19.20	10.00	70.00	.00	.00	.00	.00	1.00	2.00	100.00	1.00	3.00
1.00	22.00	2.00	.00	8.30	92.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	22.00	2.00	5.00	7.00	87.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	23.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	23.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	23.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	23.00	2.00	29.00	55.00	5.00	7.30	.00	.00	.00	3.70	100.00	100.00	1.00	3.00
1.00	23.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	100.00	100.00	1.00	3.00
1.00	24.00	2.00	5.00	12.00	75.00	5.00	1.70	.00	.00	1.70	3.00	100.00	1.00	3.00
1.00	24.00	2.00	20.00	13.60	50.00	9.00	.00	.00	.00	6.30	80.00	67.50	1.00	3.00
1.00	24.00	2.00	3.30	16.70	52.00	5.00	3.30	2.50	.00	17.00	74.00	100.00	1.00	3.00
1.00	24.00	2.00	29.00	12.50	50.00	6.70	.00	.00	.00	1.70	35.00	100.00	1.00	3.00
1.00	24.00	2.00	12.00	15.00	65.00	8.00	.00	.00	.00	.00	92.00	100.00	1.00	3.00

Zoo: 1=Dublin; 2=Fota, Time: 1= 10am....24=9am, Individ: 1=Male; 2 =Female, Season: 1=Winter; 2=Summer, Morn/after= 1=morning; 2=Afternoon; 3=Nocturnal

Tapir Feeding Experiment Dublin

Base/Exp	Time	Feed	Stand	Rest	Loco	Explore	Sex.Act	Agg	Other	Individ	Inside	Proxy
3.00	1.00	68.30	17.50	.00	5.00	6.70	.00	.00	2.50	1.00	98.30	67.50
3.00	1.00	65.80	1.70	27.50	.80	1.70	.00	.00	2.50	1.00	100.00	87.50
3.00	1.00	65.00	6.70	.00	20.80	3.30	.00	.00	4.70	1.00	80.80	71.70
3.00	1.00	56.70	7.50	21.70	6.70	2.50	.80	.80	3.30	1.00	100.00	75.00
3.00	1.00	40.80	30.80	.00	25.80	1.70	.00	.00	.80	1.00	88.30	70.00
3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	.00
3.00	1.00	33.30	5.80	54.20	3.30	2.50	.00	.00	.80	1.00	100.00	85.00
3.00	1.00	.00	44.20	55.80	.00	.00	.00	.00	.00	1.00	100.00	100.00
3.00	1.00	17.50	59.20	20.00	.80	1.70	.00	.00	.80	1.00	100.00	87.50
3.00	1.00	2.00	7.00	84.00	1.00	6.00	.00	.00	.00	1.00	100.00	2.00
3.00	1.00	.00	1.70	95.80	1.70	.80	.00	.00	.00	1.00	100.00	25.00
3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	100.00
3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	100.00
3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	100.00
3.00	1.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	.00
3.00	2.00	.00	5.80	68.30	2.50	1.70	8.30	.00	13.30	1.00	100.00	.00
3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	.00
3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	52.00
3.00	2.00	5.80	9.20	70.80	2.50	8.30	.00	.00	3.30	1.00	100.00	.00
3.00	2.00	11.00	24.00	38.00	14.00	12.00	1.00	.00	.00	1.00	52.00	.00
3.00	2.00	16.70	10.00	50.00	15.00	6.70	1.70	.00	.00	1.00	50.00	13.00
3.00	2.00	5.80	3.30	87.50	3.30	.00	.00	.00	.00	1.00	93.30	25.00
3.00	2.00	30.80	8.30	35.00	6.70	15.00	.00	.00	3.30	1.00	50.00	100.00
3.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	1.00	100.00	35.00
3.00	2.00	3.30	1.70	83.30	1.70	8.30	.00	.00	1.70	1.00	96.70	.00
3.00	2.00	60.00	16.70	.00	10.00	12.50	.00	.00	.80	1.00	20.00	.00
3.00	2.00	47.50	40.00	.00	7.50	5.00	.00	.00	.00	1.00	40.00	20.00
3.00	2.00	30.00	56.70	.00	8.40	1.70	.00	3.30	.00	1.00	100.00	100.00
3.00	2.00	37.00	7.00	26.00	15.00	13.00	1.00	.00	1.00	1.00	48.00	39.00
3.00	2.00	53.00	21.00	.00	11.00	14.00	1.00	.00	.00	1.00	20.00	4.00
4.00	1.00	1.00	49.00	.00	24.00	19.00	1.00	.00	.00	1.00	74.00	31.00

3.00	2.00	77.00	11.00	.00	8.00	4.00	.00	.00	.00	2.00	100.00	.00
3.00	2.00	53.00	25.00	.00	9.00	13.00	.00	.00	.00	2.00	61.50	35.40
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	90.80
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	100.00
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	53.00	100.00
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	34.20
4.00	2.00	28.00	8.00	50.00	4.00	10.00	.00	.00	.00	2.00	100.00	17.00
4.00	2.00	40.00	24.00	18.00	8.00	10.00	.00	.00	.00	2.00	44.00	56.70
4.00	2.00	10.00	8.00	70.00	8.00	4.00	.00	.00	.00	2.00	35.00	87.50
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	59.20
4.00	2.00	5.00	.00	90.00	2.00	2.00	.00	.00	1.00	2.00	100.00	100.00
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	.00
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	13.30
4.00	2.00	35.00	10.00	30.00	15.00	8.00	.00	.00	2.00	2.00	42.00	11.70
4.00	2.00	.00	.00	100.00	.00	.00	.00	.00	.00	2.00	100.00	11.70
4.00	2.00	49.00	11.00	14.00	17.00	8.00	.00	.00	1.00	2.00	39.00	9.00
4.00	2.00	49.00	.00	25.00	13.00	13.00	.00	.00	.00	2.00	25.00	50.00

Base/Exp: 3= Baseline; 4= Experiment

Time: 1= Morning; 2=Afternoon

Individ: 1=Male; 2= Female

N= 120

Preference Testing

Zoo	Resource	Flaps/No	Indiv	Atts	Entries	Latency	Res.Use	Duration
1.00	1.00	1.00	1.00	3.00	4.00	.00	.00	.70
1.00	1.00	1.00	1.00	2.00	.00	.00	.00	.00
1.00	1.00	1.00	1.00	3.00	.00	.00	.00	.00
1.00	1.00	1.00	1.00	5.00	1.00	.00	.00	.30
1.00	1.00	1.00	1.00	3.00	1.00	.00	.00	.30
1.00	1.00	1.00	2.00	1.00	2.00	.00	.00	1.30
1.00	1.00	1.00	2.00	.00	.00	.00	.00	.00
1.00	1.00	1.00	2.00	1.00	.00	.00	.00	.00
1.00	1.00	1.00	2.00	2.00	2.00	.00	.00	.60
1.00	1.00	1.00	2.00	1.00	1.00	.00	.00	.40
1.00	1.00	2.00	1.00	.00	1.00	.00	.00	.30
1.00	1.00	2.00	1.00	3.00	.00	.00	.00	.00
1.00	1.00	2.00	1.00	2.00	.00	.00	.00	.00
1.00	1.00	2.00	1.00	3.00	.00	.00	.00	.00
1.00	1.00	2.00	1.00	1.00	.00	.00	.00	.00
1.00	1.00	2.00	2.00	1.00	.00	.00	.00	.00
1.00	1.00	2.00	2.00	2.00	.00	.00	.00	.00
1.00	1.00	2.00	2.00	.00	.00	.00	.00	.00
1.00	1.00	2.00	2.00	1.00	.00	.00	.00	.00
1.00	1.00	2.00	2.00	2.00	.00	.00	.00	.00
1.00	2.00	1.00	1.00	.00	5.00	1.70	96.00	72.20
1.00	2.00	1.00	1.00	1.00	4.00	.60	99.00	70.00
1.00	2.00	1.00	1.00	1.00	4.00	1.20	93.00	70.00
1.00	2.00	1.00	1.00	2.00	3.00	.40	98.00	69.00
1.00	2.00	1.00	1.00	.00	5.00	.50	96.00	72.00
1.00	2.00	1.00	2.00	1.00	4.00	.40	98.50	24.30
1.00	2.00	1.00	2.00	2.00	6.00	1.10	95.00	36.80
1.00	2.00	1.00	2.00	1.00	3.00	2.10	99.00	25.00
1.00	2.00	1.00	2.00	2.00	7.00	1.40	98.00	27.00
1.00	2.00	1.00	2.00	1.00	5.00	1.50	97.00	30.00
1.00	2.00	2.00	1.00	1.00	3.00	1.20	90.00	32.10
1.00	2.00	2.00	1.00	1.00	7.00	.40	92.50	41.80
1.00	2.00	2.00	1.00	.00	11.00	1.90	94.70	43.30
1.00	2.00	2.00	1.00	1.00	8.00	2.10	96.00	37.00
1.00	2.00	2.00	1.00	1.00	6.00	1.70	97.00	41.00
1.00	2.00	2.00	2.00	.00	.00	.00	.00	.00
1.00	2.00	2.00	2.00	1.00	2.00	2.10	89.90	35.00
1.00	2.00	2.00	2.00	.00	11.00	.70	97.00	43.00
1.00	2.00	2.00	2.00	.00	4.00	.40	92.00	12.00
1.00	2.00	2.00	2.00	1.00	6.00	1.20	99.00	30.00
1.00	3.00	1.00	1.00	3.00	7.00	2.80	64.40	3.70
1.00	3.00	1.00	1.00	1.00	7.00	37.00	17.00	73.10
1.00	3.00	1.00	1.00	1.00	9.00	3.30	37.60	11.10
1.00	3.00	1.00	1.00	.00	6.00	.10	.90	81.00
1.00	3.00	1.00	1.00	.00	17.00	35.10	6.00	62.10
1.00	3.00	1.00	2.00	.00	5.00	4.90	38.20	4.50
1.00	3.00	1.00	2.00	.00	6.00	2.20	92.90	8.40
1.00	3.00	1.00	2.00	1.00	6.00	1.90	72.80	5.40
1.00	3.00	1.00	2.00	.00	5.00	.40	15.40	40.10
1.00	3.00	1.00	2.00	1.00	7.00	37.30	3.30	35.30
1.00	3.00	2.00	1.00	1.00	3.00	1.50	3.80	12.70
1.00	3.00	2.00	1.00	.00	7.00	7.60	3.20	51.50
1.00	3.00	2.00	1.00	1.00	4.00	4.10	10.30	39.50

1.00	3.00	2.00	1.00	1.00	3.00	.10	4.10	54.30
1.00	3.00	2.00	1.00	.00	3.00	37.80	1.90	51.90
1.00	3.00	2.00	2.00	.00	.00	.00	.00	.00
1.00	3.00	2.00	2.00	2.00	2.00	4.80	28.90	2.90
1.00	3.00	2.00	2.00	.00	.00	.00	.00	.00
1.00	3.00	2.00	2.00	1.00	1.00	6.90	81.90	1.00
1.00	3.00	2.00	2.00	2.00	2.00	4.60	46.90	1.60
2.00	1.00	1.00	1.00	.00	5.00	.00	.00	2.10
2.00	1.00	1.00	1.00	.00	4.00	.00	.00	1.70
2.00	1.00	1.00	1.00	.00	4.00	.00	.00	1.90
2.00	1.00	1.00	1.00	.00	6.00	.00	.00	3.00
2.00	1.00	1.00	1.00	.00	5.00	.00	.00	2.30
2.00	1.00	1.00	2.00	.00	7.00	.00	.00	1.90
2.00	1.00	1.00	2.00	.00	5.00	.00	.00	2.40
2.00	1.00	1.00	2.00	.00	6.00	.00	.00	3.70
2.00	1.00	1.00	2.00	.00	6.00	.00	.00	2.10
2.00	1.00	1.00	2.00	.00	6.00	.00	.00	2.60
2.00	1.00	2.00	1.00	.00	4.00	.00	.00	.10
2.00	1.00	2.00	1.00	.00	1.00	.00	.00	.50
2.00	1.00	2.00	1.00	.00	1.00	.00	.00	1.10
2.00	1.00	2.00	1.00	.00	1.00	.00	.00	.01
2.00	1.00	2.00	1.00	.00	3.00	.00	.00	1.60
2.00	1.00	2.00	2.00	3.00	4.00	.00	.00	.50
2.00	1.00	2.00	2.00	2.00	1.00	.00	.00	.60
2.00	1.00	2.00	2.00	.00	1.00	.00	.00	.02
2.00	1.00	2.00	2.00	.00	2.00	.00	.00	.80
2.00	1.00	2.00	2.00	1.00	2.00	.00	.00	.50
2.00	2.00	1.00	1.00	.00	9.00	.80	97.00	66.60
2.00	2.00	1.00	1.00	.00	5.00	.70	95.50	61.70
2.00	2.00	1.00	1.00	1.00	3.00	3.50	95.60	6.80
2.00	2.00	1.00	1.00	.00	3.00	3.60	95.60	14.00
2.00	2.00	1.00	1.00	.00	5.00	2.50	95.80	49.00
2.00	2.00	1.00	2.00	1.00	7.00	4.40	92.00	61.30
2.00	2.00	1.00	2.00	1.00	3.00	.50	89.70	68.80
2.00	2.00	1.00	2.00	1.00	5.00	2.80	97.10	78.30
2.00	2.00	1.00	2.00	.00	3.00	.00	97.60	34.80
2.00	2.00	1.00	2.00	2.00	9.00	2.70	92.00	46.70
2.00	2.00	2.00	1.00	.00	6.00	2.40	95.70	56.10
2.00	2.00	2.00	1.00	3.00	12.00	.10	94.10	81.30
2.00	2.00	2.00	1.00	4.00	6.00	3.90	82.00	39.40
2.00	2.00	2.00	1.00	.00	11.00	1.60	93.70	19.70
2.00	2.00	2.00	1.00	1.00	4.00	1.90	96.10	59.60
2.00	2.00	2.00	2.00	2.00	8.00	.40	85.00	52.20
2.00	2.00	2.00	2.00	2.00	14.00	.80	94.60	57.20
2.00	2.00	2.00	2.00	.00	5.00	1.30	97.70	65.10
2.00	2.00	2.00	2.00	.00	10.00	.40	96.00	57.10
2.00	2.00	2.00	2.00	1.00	10.00	.70	94.00	56.20
2.00	3.00	1.00	1.00	1.00	5.00	7.50	64.70	.50
2.00	3.00	1.00	1.00	.00	4.00	1.10	93.90	3.40
2.00	3.00	1.00	1.00	2.00	7.00	1.30	82.50	2.90
2.00	3.00	1.00	1.00	.00	4.00	5.20	72.30	1.70
2.00	3.00	1.00	1.00	1.00	2.00	2.10	56.00	3.50
2.00	3.00	1.00	2.00	.00	8.00	4.50	65.00	2.50
2.00	3.00	1.00	2.00	.00	6.00	2.10	72.80	3.70
2.00	3.00	1.00	2.00	.00	5.00	4.30	72.90	4.90
2.00	3.00	1.00	2.00	1.00	7.00	2.10	65.00	2.60
2.00	3.00	1.00	2.00	.00	4.00	3.40	80.20	3.70

2.00	3.00	2.00	1.00	1.00	6.00	.20	2.10	31.50
2.00	3.00	2.00	1.00	1.00	5.00	.90	63.10	3.90
2.00	3.00	2.00	1.00	1.00	6.00	.70	62.40	34.00
2.00	3.00	2.00	1.00	.00	5.00	1.30	71.00	14.00
2.00	3.00	2.00	1.00	.00	5.00	.30	58.00	28.70
2.00	3.00	2.00	2.00	.00	7.00	2.80	86.00	3.80
2.00	3.00	2.00	2.00	6.00	7.00	2.90	73.60	3.80
2.00	3.00	2.00	2.00	2.00	2.00	2.80	82.00	3.50
2.00	3.00	2.00	2.00	.00	6.00	.90	35.00	2.80
2.00	3.00	2.00	2.00	1.00	5.00	.30	45.60	1.70

Zoo: 1= Dublin; 2=Fota
 Flaps/No: 1=No Flaps; 2= Flaps

Resource: 1=Bare room; 2=Straw; 3= Browse
 Individual: 1=Male; 2= Female

N= 120