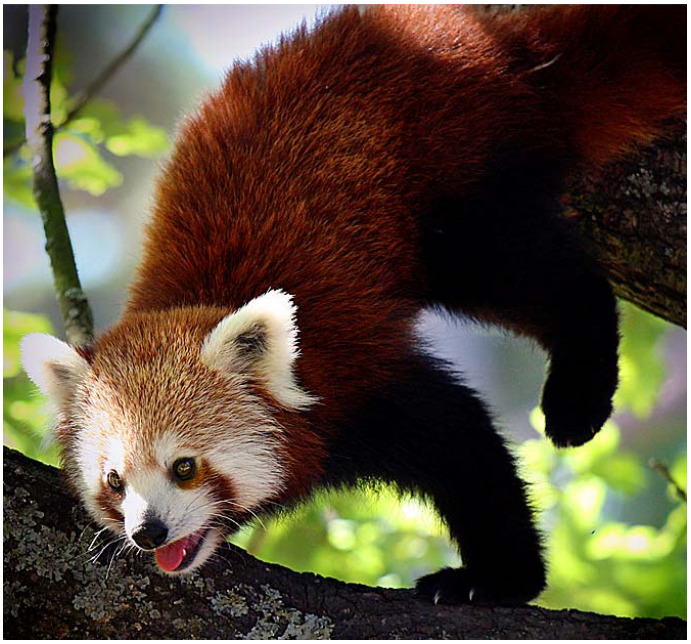
Keeping red pandas in captivity

Hållande av röd panda i fångenskap

Josefina Zidar



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Examensarbete, 15 hp, Etologi- och Djurskyddsprogrammet

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Abstract

The red panda (*Ailurus fulgens*) is an endangered species that is held in zoos worldwide. The aim of this thesis was to examine how red pandas are kept and managed in captivity. A survey with 37 questions was sent to all red panda keepers within the European Endangered Species Breeding Programme and to some zoos part of the breeding programmes in North America and Australia. Results from the survey were compared with the wild biology of the red panda and the husbandry and management guidelines for the red panda in captivity.

Red pandas have large territories in the wild, which range between 980.000-3.300.000 m^2. The result shows a mean enclosure size of 290 m^2 in the zoos. Eleven enclosures were smaller then the minimum of 80 m^2 recommended in the guidelines. Almost half the zoos had visitors around more than half of the enclosure.

The red panda is found in dense forests were fallen logs, scrubs, water and bamboo are common. They live almost exclusively on bamboo leaves and are good climbers, spending most of their time up in the trees. The results show that the most common feature in the enclosures was shrubs, followed by logs and rocks. Half the zoos had water in the enclosure. Parts of the enclosures were dedicated to climbing and many of the zoos had higher climbing structures than 4 m. Bamboo was fed once every day in over half the zoos, however, some zoos only fed bamboo every other day, once a week or sporadically.

The results show that the recommendations given in the management guidelines are not followed by all zoos and that the keeping and management of red pandas can be improved.

“The standard by which a zoo animal is judged should be the life that it leads in the wild, under so-called free conditions of nature”

/ Hedger, H. 1969

Introduction

Status in the wild

The red panda (*Ailurus fulgens*) is a unique taxonomic species that is in danger of extinction (Glatston, 1994). The main dilemma facing the wild population is loss of their habitat due to deforestation (Glatston, 1994; Wei *et al.,* 1999a). Deforestation also means that the remaining forest will be fragmented and panda populations isolated from each other in smaller areas (Glatston, 1994). The declining panda population is also sensitive to poaching and illegal trade (Glatston, 1994; Wei *et al.,* 1999a). In 2001 the wild population was estimated to 16.000-20.000 individuals (Choudhury, 2001).

At an international level the red panda is listed on the IUCN red list as an endangered species with a very high risk of extinction in the wild (Mustelid Specialist Group, 1996). Since 1995 the red panda is also listed by CITES as an Appendix I species. Appendix I, lists species that are the most endangered among CITES-listed animals (UNEP-WCMC, 2008). At a national level the red panda is listed in India in the Indian Wildlife Protection Act (Pradhan *et al.,* 2001) and in China in the Chinese Wild animal protection law, where it is stated that it is not to be hunted or caught without permission from the Ministry of Forestry or delegated authorities (Wei *et al.,* 1999a).

Distribution and habitat

The red pandas present distribution extends from Nepal trough Bhutan, India, Burma and Myanmar in the Himalayas, to China (Roberts and Glitterman, 1984; Glatston, 1994). There are two subspecies of the *Ailurus fulgens; Ailurus fulgens fulgens* and *Ailurus fulgens styani* (Wei *et al.,* 1999a). The subspecies *A.f. fulgens* is distributed all over Himalaya: in Nepal, India, Bhutan, northern Myanmar and the southwest of China, and the subspecies *A.f. styani* is found in south-central China (Choudhury, 2001).

The distribution of red pandas is restricted to temperate forests at an altitude between 1500-4800 m. (Roberts and Glitterman, 1984; Glatston, 1994). However, Yonzon and Hunter (1991) only found pandas at an altitude between 2800-3900 m. The same observations were made by Pradhan *et al.* (2001) who observed pandas more frequently at an altitude of 2800-3600 m. and Williams (2003) who found that the concentration of red pandas were higher at an altitude between 2800-3000 m.

The red panda is difficult to observe in the dense forests were it is located (Wei *et al.,* 1999a; Zhang *et al.,* 2006) therefore when investigating their status in the wild researchers have used interviews, surveys, telemetry and collection and analysing of droppings to gather information (Johnson *et al.,* 1988; Yonzon and Hunter, 1991; Wei *et al.,* 1999a; Pradhan *et al.,* 2001; Mahato, 2004; Zhang *et al.,* 2006). Estimating the amount of red pandas by collecting droppings has shown to be a good method as high amounts of droppings are found at the same places were most sightings of red pandas occur (Pradhan *et al.,* 2001).

Throughout the pandas existing habitat different forests are available and preferred by the panda. In the Kangchenjunga region surveys for signs of pandas and interviews show that red panda habitat in the area consists of Himalayan fir forest. Vegetation in this forest consists of Himalayan fir, rhododendrons, maple and viburnum with a thick undergrowth of ringal bamboo (Mahato, 2004). In a study by Pradhan *et al.* (2001) in Singhalila National Park in India, pandas preferred broadleaf forests to sub alpine and oak forests. The density of pandas was highest in the broadleaf forests and lowest in the oak forest. A study in Langtang National Park in Nepal which has three vegetation zones showed that fir and bamboo were strongly preferred by red pandas, seeing that only 10% of the park is fir-bamboo forest (Yonzon and Hunter, 1991).

Why have red pandas in zoos?

The pleasing manner and appearance of the red panda makes it an attraction for zoo visitors. The gained knowledge about the panda's situation may awake interest from visitors to help save them (Glatston, 1994). Public awareness is an important goal in the captive breeding programme (Glatston and Leus, 2005).

A total of 249 red panda keepers and a total of 759 red pandas were registered in the studbook in 2008 (Glatston, 2008). The captive population of red pandas provides a backup population for the wild population (Glatston and Leus, 2005).

The captive population could also be used to reintroduce individuals into the wild (Glatston and Leus, 2005). A first attempt to release pandas back into the wild took place in 2003, when two captive bred female pandas in India were released. One of the females successfully mated and gave birth to a cub in 2004. They were last seen one month after she gave birth, and at that time both were alive (Glatston and Leus, 2005). Furthermore, as a flagship species the red panda can serve to support natural resource management in its home range (Yonzon and Hunter, 1991).

Reproductive problems and high infant mortality

Despite the fact that the red panda as a population can benefit from a captive population, their breeding success in zoos has been quite poor (Glatston, 1992). Because the wild population of red pandas is threatened, zoos can not restock with individuals from the wild; they have to have breeding success and pandas that live long lives (Glatston, 1992).

In the global captive breeding masterplan it is stated that the global captive population should maintain a minimum of 90 % of the genetic variation during a 100 years; this without the use of new individuals from the wild (Glatston and Leus, 2005). To reach this goal the captive population will have to increase. However, high percentage of infant deaths and low reproductive success can make this difficult (Glatston and Leus, 2005). The problem with infant mortality seems to be higher in some regions, suggesting that it might be a management problem (Glatston and Leus, 2005).

High mortality in infant pandas has been investigated by Yinghong (1994). Yinghong found that the registered mortality rate for infants (cubs less then one year old) was 42.70 % between the years 1978-1992. The most deaths occurred 1-3 days after birth. Between 8 and

30 days the survivor rate stabilized to decline again after 30 days. One of the most common reasons for death was lesions in the respiratory system with pneumonia as the most observed problem. Malnutrition and asphyxia were also reported as being common (Yinghong, 1994).

Aim of the thesis

The aim of this thesis was to examine how red pandas are kept and managed in captivity and compare that with how they live in the wild. The husbandry and management guidelines for red pandas were last altered in 1989. At that time the information about distribution, status in the wild, ecology or normal behaviour was almost nonexistent. Since then, field studies have been undertaken throughout their home range. Hopefully, the results from this thesis can improve the recommendations for maintaining red pandas in captivity and make it easier to pinpoint what factors influence the difficulties facing the captive breeding programme with low reproduction success and high infant mortality rates.

Material and methods

A survey was sent out in 2007 by David White at Marwell Zoo. The survey was sent out initially to all red panda holders within the EEP. From there, Angela Glatston at Rotterdam Zoo forwarded the survey to North American and Australian zoos that are part of the global breeding programmes. The answers were inserted and processed in Microsoft Excel version 2003. The survey included 37 questions (Appendix 1), of which 25 has been chosen in this thesis. Not all questions were answered by all zoos that answered the survey, therefore in the following text, the number of responding zoos are shown in brackets for each question. Means are shown with standard deviation (S.D.). No difference between the two subspecies has been made.

Results and Discussion

Out of the 69 zoos that responded to the survey 47 were European zoos, 9 Australian zoos and 13 North American zoos.

Climate

Captive pandas are found in zoos worldwide and are therefore subject to different climates (Yinghong, 1994). The average mean summer temperature in the responding zoos (65/69) was 23.6 (± S.D. 4.9) ˚C but answers ranged between 12-36 ˚C. The warmest temperature found in panda habitat is 29 ˚C (Wei *et al*., 2000a). Zoos were asked to give an average summer temperature and not a max temperature; therefore it is difficult to see which zoos that exceed 29 ˚C. But, because there were some zoos with average temperatures above 30 ˚C the maximum temperatures must be well above the 29 ˚C in their natural habitat. High temperatures may therefore be problematic in some enclosures. This is consistent with Yinghong (1994) who saw a possible link between climate-induced stress and disease and high infant mortality in warm climates and Glatston (1992) who point to several occurrences

of heat stress in warm temperatures. Zoos in warm climates have also had lower breeding success when shade hasn't been offered (Glatston, 1992). Consequently in the management guidelines it is stated that there should be some shade in the enclosures throughout the day (Glatston, 1989). All of the responding zoos (67/69) had shade to some extent. A total of 88.0 % had part shade in the enclosure, 6.0 % had full shade and 6.0 % had part to full shade.
In warmer areas additional cooling systems can be used. Some kind of cooling system was used by 27.94 % of the responding zoos (68/69). Most commonly used were sprinklers, misting spray and A/C. A total of 16 zoos reported an average temperature above 27 ˚C and out of these 16; five reported that they did not use any kind of cooling systems.

The coldest temperature observed in panda habitat is -17 ˚C (Yonzon and Hunter, 1991). The panda is adapted to cold climate with its thick coat and fur-covered paws (Glatston, 1992). Keeping pandas in northern countries were temperatures resemble their natural climate should not be a problem.

Enclosure size

In field studies, red panda territories have been estimated to range from 980.000 m^2 to 3.300.000 m^2 (Yang *et al.* 2006). Enclosure size in the responding zoos (66/69) ranged from 21.6 m^2 to 1100 m^2. The mean enclosure size was 290 (± S.D. 245) m^2 (fig 1).

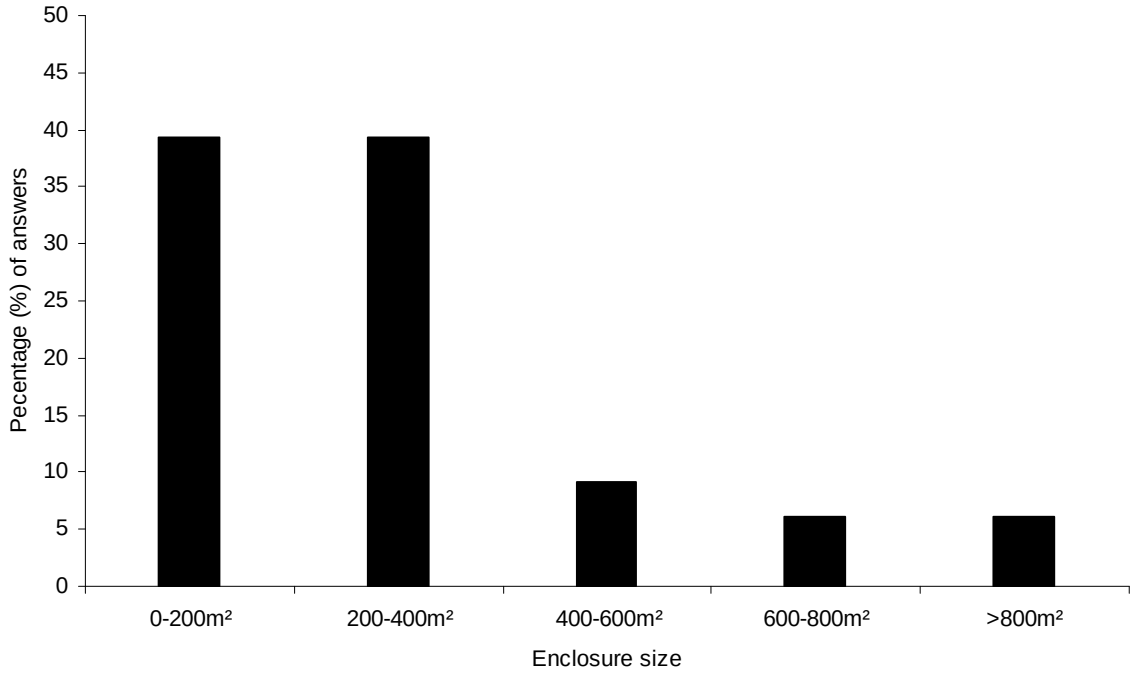

Fig. 1. Differences in red panda enclosure size (*n*=66).

Zoos have limited boundaries were space not only have to be divided between all the animals that are kept there but also make room for the visitors and people working there (Stroud, 2007). Enclosures in zoos may therefore not be able to have the exact same size and conditions as natural territories. However, Tennessen (1989) lists available space and its complexity as one of four components that influence management success in captivity. When designing enclosures it is important to remember to look at the quality and complexity of space not only the quantity of space. In the case of the red panda one may argue that having

huge enclosures is not the most important aspect. Red pandas may for example benefit more from high enclosures with climbing opportunities as they live mostly arboreal (Glatston, 1994). This is true when discussing large enclosures compared to huge enclosures. However, more than half of the zoos had smaller enclosures than 300 m^2 and a total of 11 zoos (13.64 %) even had smaller enclosures than the minimum of 80 m^2 suggested in the husbandry and management guidelines (Glatston, 1989). When analyzing the enclosures presented by the zoos it becomes apparent that we should be discussing small enclosure compared to extremely small or medium enclosures. The enclosure size determines how much the panda can explore and perform natural behaviours. It affects the number and placement of nest boxes, resting places, feeding stations, logs, shrubs and water sources which are important features within the enclosure. Small enclosures also hinder the panda to get away from public disturbance. The animal has to be able to perform natural behaviours and function physiologically to cope in their captive environment (McGreevy, 2007; Stroud, 2007).

Another aspect that needs to be discussed in association with enclosure size is the social environment. Tennessen (1989) point out that the social environment with groups, population size and stocking density is important for successive management. Red pandas live solitary, only meeting when females are in estrous (Yonzon and Hunter, 1991; Pradhan *et al.,* 2001) during a period of 12-36 hours to copulate (Spanner *et al.,* 2007). Red pandas in captivity are on the contrary mostly held in pairs (Glatston and Leus, 2005). Yang *et al.* (2006) found that territories overlap between all pandas despite gender. This suggests that pandas accept other individuals to some extent even in their own territories. However, in captivity were enclosures are small and limited individuals may have difficulties getting away from bullies. When keeping solitary animals in other social groups space for each individual must be considered. Group size influences behaviour, welfare and reproductive success and inappropriate groups can result in a decline in reproductive success and lower infant survival (Price and Stoinski, 2006).

According to Price and Stoinski, (2006) captive group constellations are more flexible than wild ones because of changed environmental factors such as no predation risk or competition for food. In several species, animals have been observed to thrive in constellations different from their constellations in the wild (Price and Stoinski, 2006). Wei *et al.* (2004) studied pandas in different mating constellations; monogamy, polygamy and polyandry. All female pandas gave birth except the female in polyandry. Her concentration of estradiol metabolites was five times higher than the other females; she hid from the males and avoided courtship. This indicates that polyandry is not a suitable alternative for keeping red pandas. The authors also had reservations for keeping pandas in polygamous groups but their results could not strengthen that hypothesis (Wei *et al.,* 2004). A survey sent out to zoos in 1979 showed the same tendencies with greatest success with paired individuals. It appeared that not all females in polygamy groups gave birth (Glatston, 1980). In the same study no correlation between enclosure size and low reproductive success in red pandas were found (Glatston, 1980), suggesting that the size is not the deciding factor, at least if thriving is based on reproductive success.

Outside disturbance

According to the management guidelines red panda enclosures should not be placed close to aggressive animals and should be at least 50 meters away from large carnivores (Glatston, 1989). It is also stated that viewing access by visitors should be restricted to one or two sides of the enclosure (Glatston, 1989).

The results show that neighbouring enclosures were less then 15m from red panda enclosures in 91.2 % of the responding zoos (68/69). There were large carnivores in 29.4 % of the neighbouring enclosures and large cats in 14.7 % of the neighbouring enclosures in the responding zoos (69/69). A total of 47.0 % out of the responding zoos (69/69) had more than 3/4 viewers' access around the enclosure and 14.0 % had visitor access around the whole enclosure (fig 2).

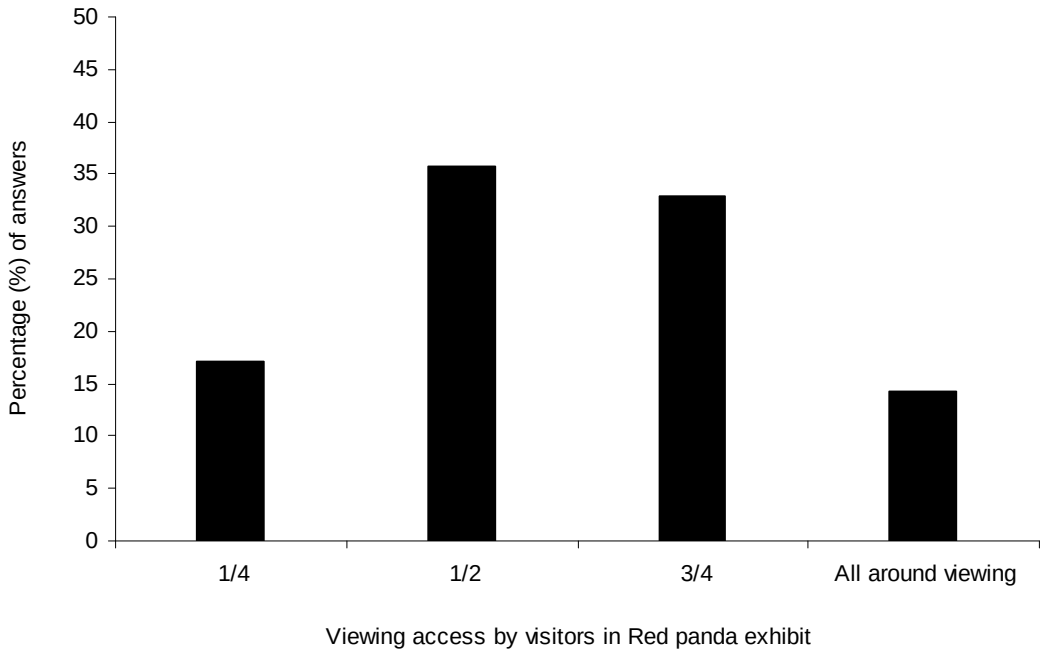

Fig. 2. Differences in viewing access by visitors around red panda enclosures (*n*=69).

As space is limited; enclosures may have to be situated close to each other. It would however seem reasonable to keep predators to the red panda at a good distance to avoid stress. Lack of control is one of the main stressors for captive animals (Tennessen, 1989). Some argue that predators are a natural part of an animal's life. In a confined situation however, animals lose control of their situation, their environment and activities (Tennessen, 1989). Animals are not allowed to influence the environment they live in or with which individuals they socialise (Tennessen, 1989). We decide what and when they eat, where to flee from predators or bullies, what kind of shelter to seek from the weather and where to give birth (Tennessen, 1989). An animal that can't influence the outcome of a situation, develop a learned hopelessness (McBride and Craig, 1985).

Glatston (1992) observed a red panda with cubs that was unwilling to enter her nest box when she was observed. According to field research the red panda select both spots for activity and resting places with good protecting canopy cover (Johnson *et al.*, 1988; Williams, 2003). Out of the whole area where activity took place, 76.9 % were places covered with bamboo (Johnson *et al.*, 1988). Resting places were at various sites and at different heights in places that both provide good cover and lookout (Johnson *et al.*, 1988). Zoos should therefore avoid having viewers access all around the enclosure and should provide some form of protection from viewers were the panda can feel in control and be able to hide. A more complex captive environment will give the animal an opportunity to feel in control of its situation (Tennessen, 1989).

Interior

Many zoos had several different features in the enclosure. Shrubs were the most common feature found in 88.4 % of the responding zoos (69/69), followed by logs 76.81 % and rocks 72.46 % (fig 3).

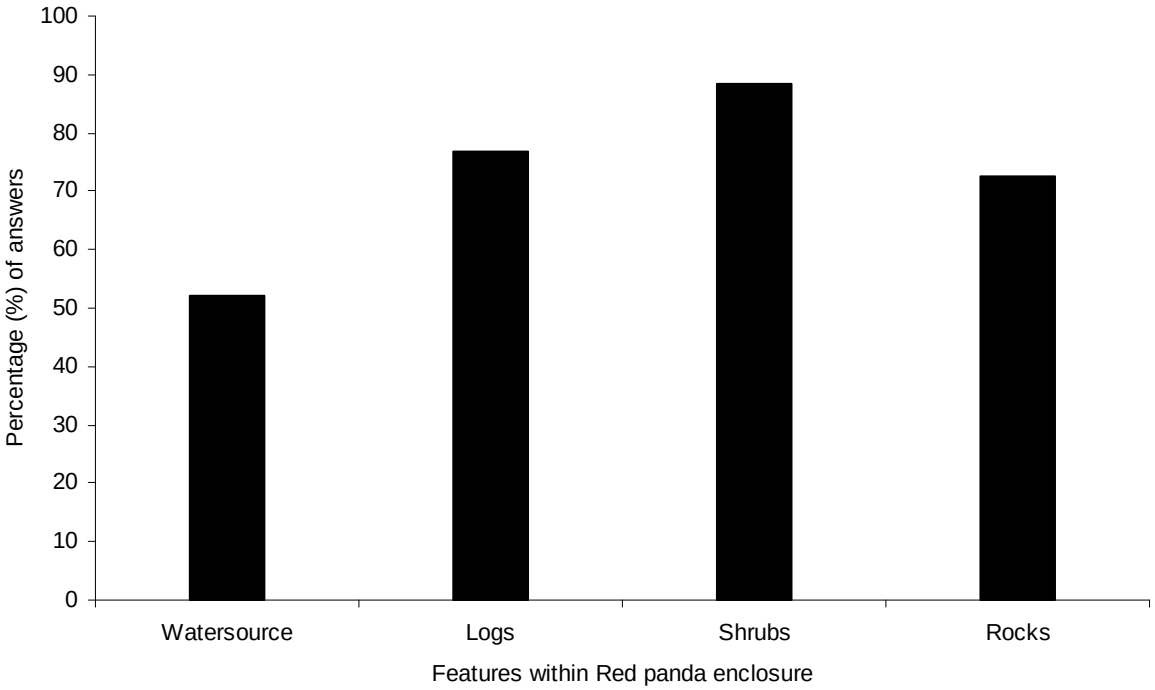

Fig. 3. Frequency of different features in red panda enclosures (*n*=69)

When designing an enclosure that closely resembles the natural environment of red pandas, you will automatically get natural behaviours, like foraging leaves from trees, investigating surroundings, climbing trees etc (Glatston, 1992). Furthermore as Glatston (1992) points out there is an educational value, where visitors for instance may learn how the red panda camouflages itself in the surrounding environment.

In the wild the red panda can be located in steep slopes were fallen logs, scrubs and bamboo are common (Wei *et al.*, 2000a). Zhang *et al.* (2006) found that fallen logs and tree stumps were important microhabitat characteristics but that slopes were probably not an important

characteristic for red pandas. The Giant panda did however prefer gentler slopes and that might explain why red pandas often utilize steeper slopes (Zhang *et al.,* 2006). In steep slopes fallen logs often cross the leaf cover and rhododendron branches reach into the bamboo (Wei *et al.,* 2000a). By walking on the fallen logs, branches, bushes and tree stumps they gain easy access to bamboo (Johnson *et al.*, 1988; Wei *et al.,* 1999a; Wei *et al.,* 2000a). When giving bamboo in zoos, a good idea may therefore be to put bamboo at places where pandas have to walk on logs, branches or bushes or tree stumps as they do in the wild.

Gladly, the most common features in zoo enclosures are the same features often found in panda habitat. Studies have shown a correlation between body size of the red panda and density and dispersion of fallen logs and tree stumps (Wei *et al.,* 2000a; Zhang *et al.,* 2004). It would therefore be interesting to find out how many scrubs and logs zoos use in their enclosures and how they are distributed. Distributing the features in the enclosure in a way that resembles the red pandas habitat can make the enclosure more interesting for the red panda to explore.

Red pandas are known to swim well (Glatston, 1989) still water was the least common feature in the enclosures, found in 52.17 % of the zoos (69/69, fig 3). Several studies indicate that water is a basic requirement for pandas; Pradhan *et al.* (2001) found 79 % of animal evidence sites in close proximity to water. The same conclusion was made by Yonzon and Hunter (1991) who found droppings near water 90 % of the time. Similarly Wei *et al.* (1998) found that vegetation, water source and human disturbance were the main factors for habitat choice. Shelter, slopes and bamboo density was also important but not prime factors. The authors concluded that the optimal habitat for red pandas in the area were a mix of broadleaved and deciduous forest with at least a 1000 m. distance to humans and a water source no more than 250 m. away. If water is one of the panda's fundamental requirements for habitat in the wild it should also be a natural part of the enclosure in the zoo.

Pandas are arboreal, living mostly in trees (Glatston, 1994). They also use trees to escape from predators (Glatston, 1994). Out of the responding zoos (69/69), 4.0 % had dedicated the entire enclosure to climbing, whereas, 22.0 % had only dedicated ¼ of the enclosure to climbing (fig 4). Estimating how big part of the enclosure that is climbable is difficult and may vary individually, for that reason these results should be read with caution.

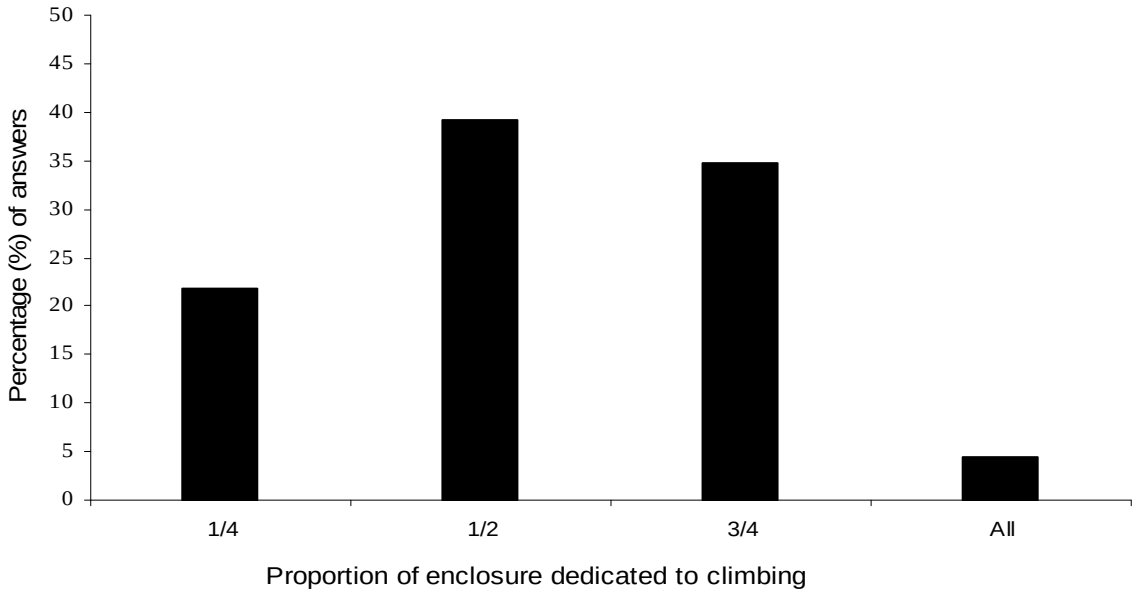

Fig. 4. Proportion of red panda enclosure dedicated to climbing (*n*=69).

According to the husbandry and management guidelines the highest climbing structure should be at least 4 m. (Glatston, 1989). Out of the responding zoos (67/69), 83.58 % had higher climbing structures than 4 m. In a captive environment it is important that an animal has the possibility to get away or hide, for the panda a tree may be more sufficient than an indoor enclosure at ground level. Having climbing opportunities in the enclosure gives the red panda the chance to behave naturally. It would be interesting to know how many trees that is available in the enclosures.

It is recommended to use natural substrates with edible grasses within the enclosures (Glatston, 1989). In the responding zoos (69/69) the most common substrate was grass found in 91.3 % of the zoos. Many enclosures had a mixture of different substrates (table 1). In the 7.25 % of the enclosures were edible grasses were not available woodchip was used as substrate. Even though woodchip probably is a better substrate than concrete it will not supply the panda with the availability to forage grass. In absence of bamboo or other enrichments, grass may be a good substitute giving the panda the opportunity to forage throughout the day.

Table 1. Substrates in red panda enclosures (*n*=69).

Substrate	Number of answers (*n*=69)	Enclosures (%)
Grass	63	91.30
Woodchip	30	43.48
Concrete	9	13
Gravel	5	7.24
Forest floor	3	4.35
Sand	2	2.9
Peat	2	2.9

Feeding

Red pandas have been observed to carefully select tender (Wei *et al.,* 1999bc) green bamboo leaves which are carefully pinched from the stems and chewed thoroughly (Johnson *et al.*, 1988). Approximately 63 % of the bamboo leaves are eaten on the bamboo plant (Johnson *et al.*, 1988). To identify bamboo consumption in red pandas and to estimate its importance Yonzon and Hunter (1991) analysed faeces to see how pandas utilize bamboo. Their results show that the red pandas diet consists totally of plant matter available all year around. Bamboo leaves were 54-100 % of their diet depending on season. Johnson *et al.* (1988) showed that the diet of a single red female panda consisted of 99.1 % bamboo leaves. In another study 93.7 % of droppings consisted of bamboo (Reid *et al.,* 1991). Similarly Wei *et al.* (1999b) found that bamboo made up 89.9 % of the yearly feed. Seasonal fruit, mushrooms and bamboo shoots complement the panda's diet (Johnson *et al.,* 1988; Reid *et al.,* 1991; Yonzon and Hunter, 1991; Wei *et al*., 1999b; Pradhan *et al.,* 2001).

To survive on such low nutrients pandas have adapted morphologically, physiologically and behavioural (Wei *et al*., 1999c). A lot of bamboo has to be consumed daily to fulfil the requirement of energy (Wei *et al.,* 2000b). Yonzon *et al.* (1990) even found that pandas forage throughout the day and night because of their low nutritional diet.

The management guidelines recommend that 200 g bamboo should be fed once a day to each panda (Glatston, 1989). A total of 68.11 % of the responding zoos (69/69) fed bamboo once every day; a few (10.14 %) fed bamboo twice every day. Some zoos only gave bamboo every other day (5.8 %) and some (8.7 %) gave bamboo once a week. The remaining zoos (7.25 %) could not answer the question in detail; they said it was given sporadically or rarely (fig 4).

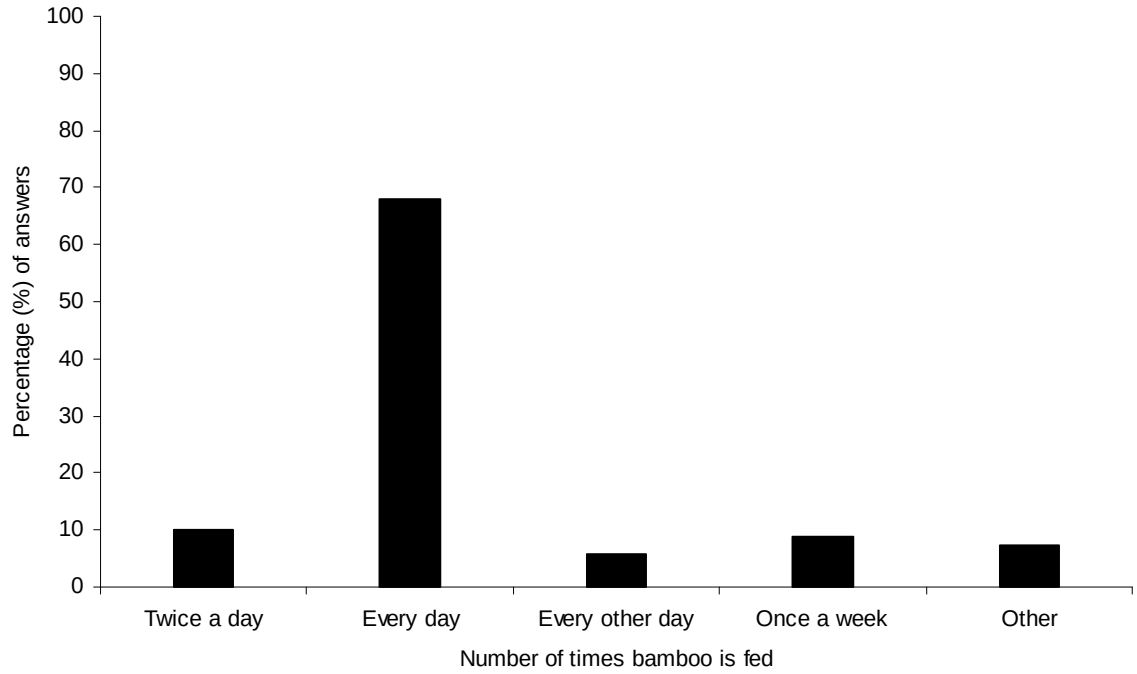

Fig. 4. Number of times bamboo is fed to red pandas (*n*=69)

It is difficult for zoos to supply bamboo to fulfil the red pandas nutritional requirements. To increase the amount of protein and fibre in their feed, concentrate is normally recommended as a substitute to bamboo (Plume, 2004). Biscuits and other food sources that have nutrients in a concentrated form may give the panda the exact nutrients it requires but may also be a source of stress for an animal that is adapted to spending a lot of time eating. It is important to not only think about the nutritional requirements but also to consider the behaviour repertoire of the panda.When time normally spent on foraging is left unfilled, other activities has to fulfill that time. Han *et al*. (2005) showed that activity was lower in captive red pandas than wild red pandas. The same problem has been observed in giant pandas (Swaisgood *et al.*, 2001). Alternative ways to activate the giant panda in captivity with enrichments (plastic objects to manipulate, burlap sacks full of straw, spruce branches, fruit in ice, and puzzle feeders) was investigated and showed an increase in activity and in varied behaviours and a decrease in stereotypic behaviours and feeding anticipation behaviours (Swaisgood *et al.*, 2001). Swaisgood *et al.* (2001) also point at the positive effects of enrichments with successful breeding, rearing of young and better suited individuals for reintroduction into the wild.

Red pandas in captivity should be fed at least twice a day (Glatston, 1989). Out of the responding zoos (68/69), 19.12 % gave food only once a day. A total of 57.35 % gave food twice a day (fig 5).

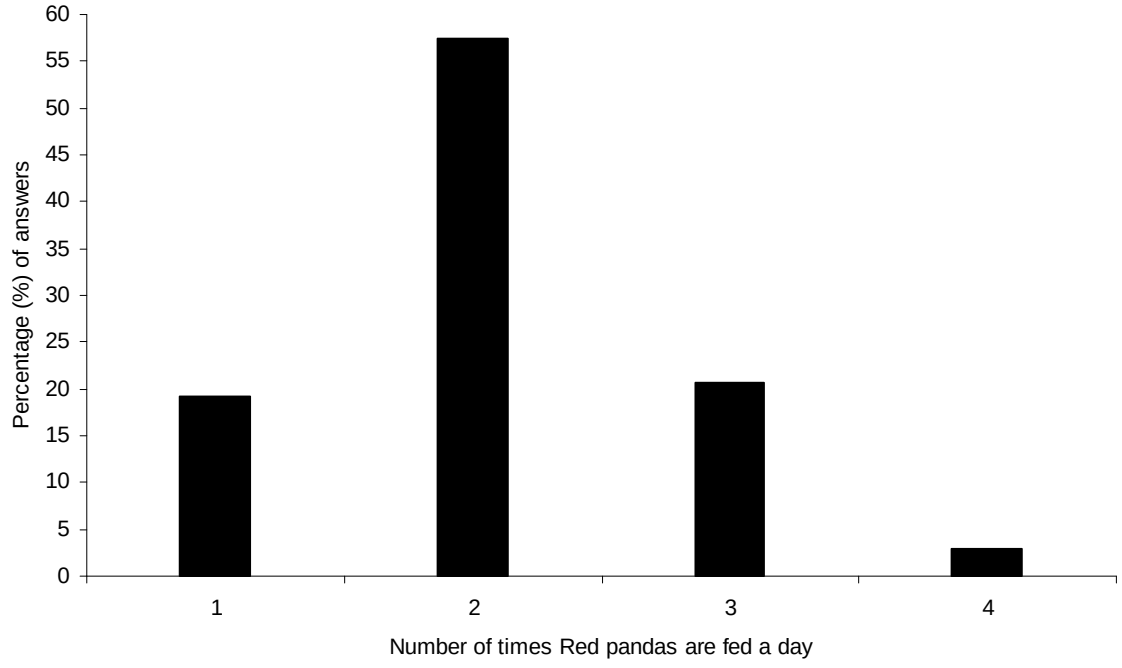

Fig. 5. Number of times red pandas are fed a day (*n*=68)

The number of feeding stations used in the responding zoos (69/69) differed from 1 up to 8 per panda, 28.99 % of the zoos said that they had one feeding station. A total of 42.03 % had two. In 15.94 % of the zoos, more than four feeding stations were used. When designing enclosures, food sources are often easily available with concentrated foods which lead to less activity, foraging and eating (McGreevy, 2007). In the wild pandas are active at night with a peak of activity during nightfall and sunrise, indicating that red pandas are crepuscular and nocturnal (Johnson *et al.*, 1988). Reid *et al.* (1991) reported that activity was higher in daytime during the summer months when arboreal foraging took place. Captive pandas are on

the other hand more active during daytime with an average activity of 58.0 % during daytime and 42.0 % during night (Han *et al.*, 2005). Having several feeding stations in the enclosure and giving food several times during the day may help to activate the captive pandas. Ninomiya *et al.* (2004) showed in horses that increasing the number of times horses were fed and increasing the number of feeding places resulted in feeding satisfaction and calmed feeding frustration.

Behaviour

Aggressive behaviour doesn't seem to occur that often in captive pandas, only 1.45 % of the responding zoos (69/69) reported that they saw aggression often, 33.33 % had never seen aggressive behaviour and 10.14 % said that it occurred occasionally. However, 55.07 % said that aggression was rare, showing that aggression do occur (fig 7).

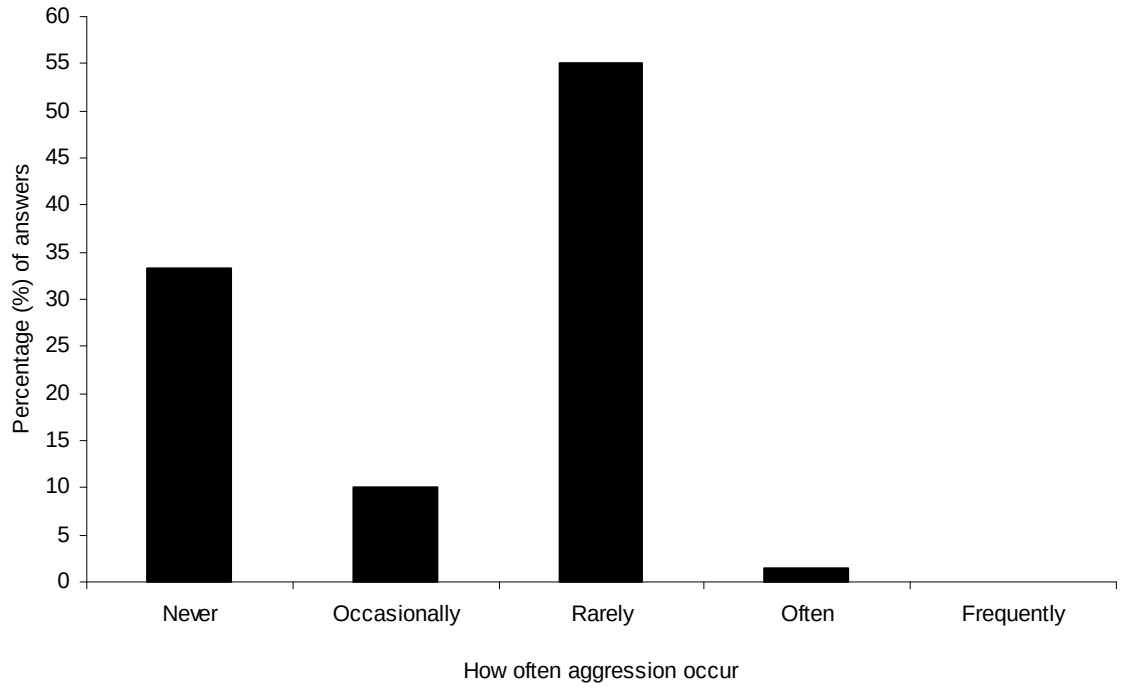

Fig. 7. How often aggressive behaviour occur in red panda enclosures (*n*=69)

In the responding zoos (43/69), aggressive behaviour was most common during sexual activity, feeding and when animals were introduced or re-introduced. But it also occurred in competition over resting places or nesting places, towards the keepers and males towards cubs. If aggression occurs during feeding it could be a sign that not enough feeding stations are available. The same could be true about resting places and nesting boxes.

Breeding

When red pandas give birth they become more sensitive to public disturbance (Glatston, 1989) and for that reason zoos should adjust the environment during breeding season. During breeding season 44.9 % of the responding zoos (49/69) practiced minimal disturbance at the enclosure. Spanner *et al.* (2007) points out that females that stay unmated, may lack behavioural, hormonal or environmental stimulus due to husbandry insufficiency, behavioural incompatibility, or male faults.

Females in enclosures with more than one nest box have shown more willingness to rear their young (Glatston, 1992). According to management guidelines at least three nest boxes should be provided in the enclosure (Glatston, 1989). Out of the responding zoos (68/69), 39.71 % had less than three nest boxes available and 5.88 % only had one single nest box (fig 8).

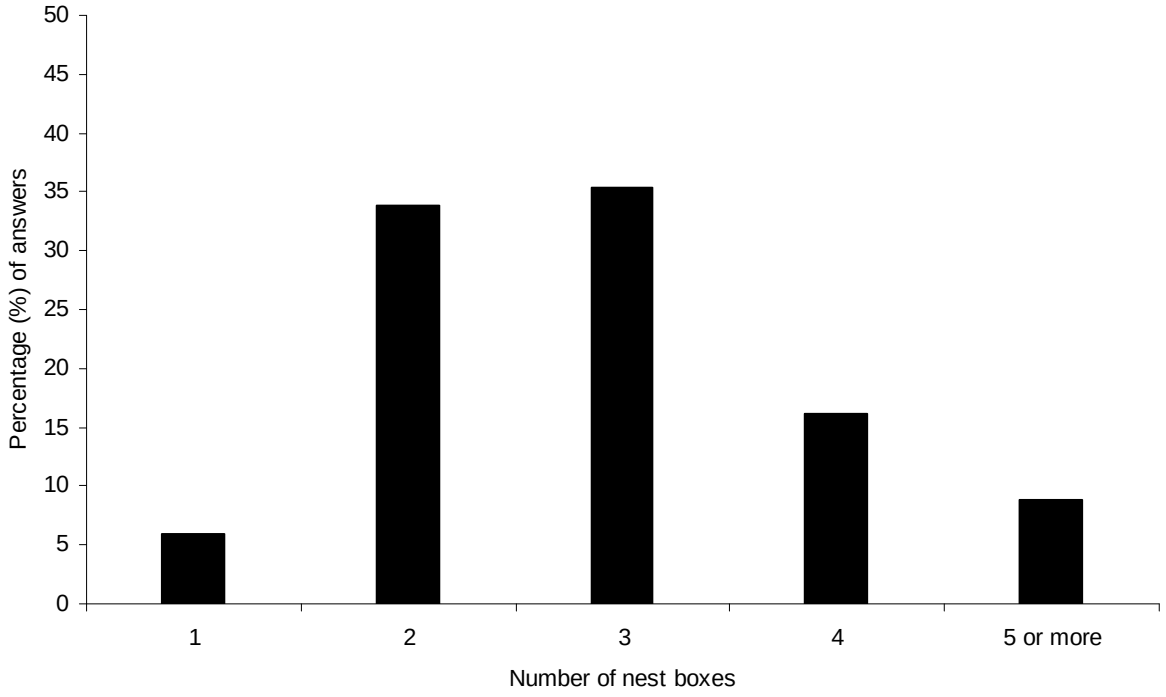

Fig. 8. Number of nest boxes in red panda enclosures (*n*=68)

Because females tended to move cubs around, some zoos in this survey recommended that more than five nest boxes should be available. A total of 8.2 % reported to have more than five nest boxes (fig 8). Studies have shown that females move their cubs if the nest box is to warm (Gu, 1984 mentioned by Yinghong, 1994).

The lowest placed nest boxes in the responding zoos (67/69) were placed under ground (5.97 %) although more than half (55.22 %) of the lowest nest boxes were placed at ground level. Out of the responding zoos (67/69), 10.44 % had the highest placed nest box at 3-4 m. Still, 32.84 % had their highest placed nest box below 1 m. It is more natural for a panda to use a nest box high up as red pandas give birth to their cubs in nests up in trees (Glatston, 1994).

Of the responding zoos (50/69), 14.0 % have had to hand rear cubs at some point. Female neglect was the cause in 57.14 % of these incidents. As previously mentioned, Glatston (1992) observed reluctance in a female panda to enter the nest when she was observed by visitors; therefore covering the nest box could help the panda to feel comfortable. In fact, the

female panda in Glatston's study (1992), dared entering the nest after they had concealed the nest box with plants.

Neonatal death was reported to have occurred at some point in 50.0 % of the responding zoos (46/69). However, it is not possible to make out how often neonatal death occurred in zoos that had observed it, only that at some point during the years they have held pandas it has occurred. Therefore the result should be read with caution.

Health

The most common health problems reported from the zoos was bad teeth, parasites and hair loss. Hair loss was reported from 45.31 % of the responding zoos (64/69, fig 9).

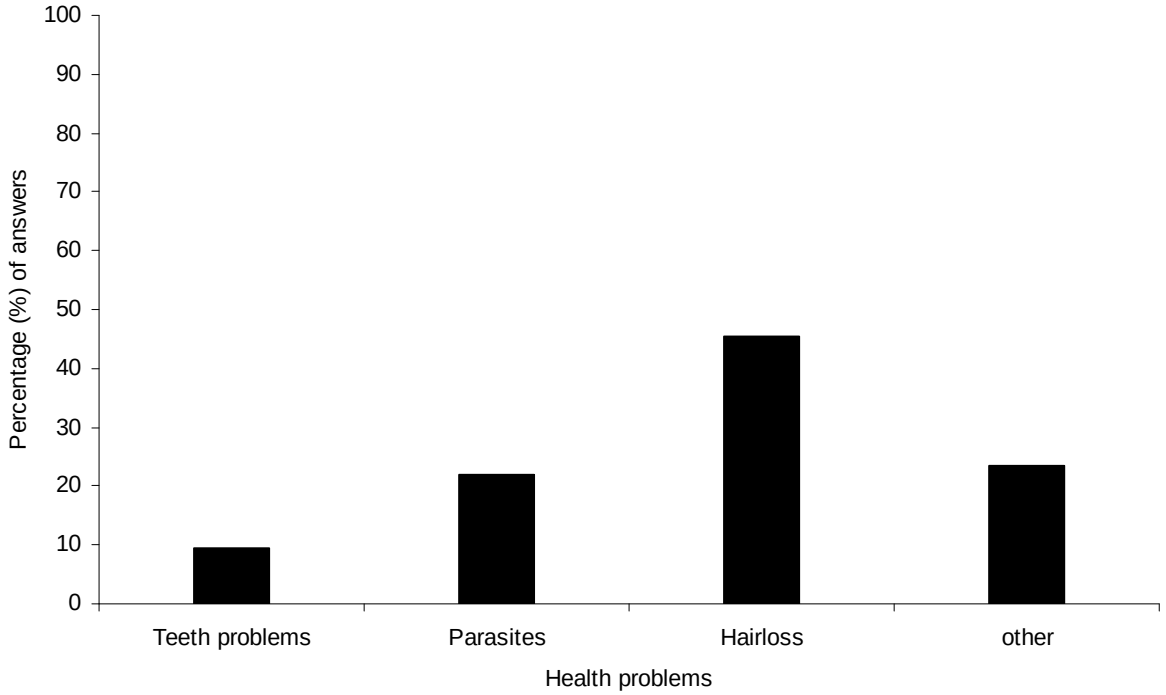

Fig. 9. Common health problems in captive red pandas (*n*=64).

The teeth problem is probably correlated with high amount of sugar given in the pandas feed. To avoid this problem sweet gruel should not be fed to pandas (Glatston, 1989). All parasitic conditions were treated. Some zoos did however not treat hair loss. Two reasons were given. One, because they did not know what had caused it; and two, they saw it as a seasonal occurrence. Those who did try to treat the hair loss used vitamins and minerals, insecticide (Selemectin) for parasites that infect skin and hair coat, flea control (Inferno), parasitic injections (Ivomec, Cydectin) and additional hormone (Tyroxic). Stress was reported by two of the zoos as a possible cause to hair loss. Hair loss due to stress is known to occur in several species in captivity that normally does not lose hair in the wild (Honess *et al*., 2005). It has been disputed for a long time if hair loss can be caused by stress, but recently researchers have shown in mice that stress indeed may cause hair loss (Arck *et al*., 2003). In a study were hair loss in Rhesus monkeys was investigated they could see that hair loss varied with season and sex. They also found a correlation between available enclosure space, housing system, and group size and composition to coat condition (Steinmetz *et al*., 2006).

Conclusions

The result demonstrates that zoos that keep the red panda not necessarily follow the husbandry and management guidelines for captive red pandas. The result shows that the keeping and management of red pandas in captivity can be improved. Enclosures are small indicating that enclosure size for pandas is not prioritized by zoos. Enclosures in some zoos are even smaller then the minimum recommendations of 80 m^2. Almost half the zoos have visitors around big parts of the enclosure despite the recommendation of restricted visitors' access to two sides of the enclosure. The result shows that carnivores are placed in nearby enclosures, despite the recommendation of at least 50 m. distance. Bamboo is not fed every day in all zoos and some zoos give it only rarely despite the recommendations of 200 g bamboo to each panda, every day. The results show that many zoos offer less nest boxes then recommend.

The same survey or a complemented version could be sent to all keepers of the red panda to get results from all regions were the panda is kept. The survey could benefit from some additional questions and some modifications.

The following improvements could be made. Instead of asking for the mean summer temperature it would be a good idea to ask for the maximum summer temperature. That way we can see all zoos that should be aware of the risk of high temperatures and consider cooling systems. Instead of asking how large part of the enclosure that is climbable it would be better to ask for the number of climbable structures. This would give better data for comparison. To complement the question of interiors we could ask how many logs, shrubs and rocks are available and how they are distributed. We could also ask if the water sources in the enclosures are used and in what way. This could help us determine if all zoos should have water sources in the enclosure. Another question that could be asked is if enrichments are used, what kind of enrichments that are used, and how often they are available.

Future studies could investigate the cause of hair loss in captive pandas. If it is related to stress, the results could indicate that there are deficiencies in the captive environment, and in that case that has to be investigated further. Future field studies where camera traps could be placed near water sources could investigate in what way water is important for red pandas.

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Appendix 1

red panda Husbandry Survey

Dear red panda Holder,

It has been a number of years since the management of red pandas in captivity has been reviewed. The attached survey will be used to collect data from all institutions holding red pandas worldwide. The data collected will give a useful comparison between institutions that are successful and those who are not in breeding red pandas. The results will also be used in updating the husbandry guidelines for this species.

Please answer all questions in as much detail as possible for The red pandas in your collection. Please forward any photos of your red panda enclosures showing nest boxes, climbing structure, barriers etc these will be useful in helping to answer some of the questions.

Please return your responses by post, fax or e-mail to;

David White

Marwell Zoological Park

Colden Common

Winchester,

Hampshire

S021 1JH

Fax: 01962 777511

E-mail: davidw@Marwell.org.uk

Name of Collection: _____

Contact Person: _____

Enclosure

1. Please give approximate dimensions of The red panda enclosure:

   _____

2. What primary barriers are used?

   _____

   _____

3. Approximately how much of The red panda enclosure can be accessed for viewing by visitors?

   ☐ ¼ ☐ ½ ☐ ¾ ☐ all round viewing

4. What is the approximate distance to the next animal enclosure (in metres) from the red panda enclosure?

   ☐ 1-5m ☐ 6-10m ☐ 11-15m ☐ >16m

5. Please list the species in neighbouring enclosure(s)

   _____

6. Please tick the substrate(s) used within your red panda enclosure

   ☐ Grass ☐ Woodchip ☐ Peat ☐ Concrete

   ☐ Other (please list) _____

7. Please estimate the proportion of the enclosure that is dedicated climbing apparatus?

   ☐ ¼ ☐ ½ ☐ ¾ ☐ All

8. Are the climbing structures:

☐ Natural (e.g. trees, shrubs) ☐ Artificial (Wooden poles etc)

☐ Mixture of both

9. Approximately, what is the highest structure that The red panda can climb (in metres)?

_____

10. What other features are within The red panda enclosure?

☐ Pond ☐ Ro ☐ Shrubs/plants ☐ Logs

☐ Feed Station ☐ Other (please state) _____

11. Are the red pandas enclosureed with any other species? ☐ Yes

☐ No

12. If so, which species? _____

13. How many nest boxes do The red panda have access to?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+

14. What are the approximate dimensions (in centimetres) of the nest box?

Length _____

Height _____

Width _____

15. What is the approximate height (in metres) of the

    Highest placed nest box _____

    Lowest placed nest box _____

16. Are the nest boxes insulated in anyway?

    _____

17. What nesting material is used? _____

18. How much shade is offered ;

Around the nest boxes _____

In the enclosure _____

(State Full shade , Part shade , no shade for each)

19. What is the average summer temperature for the area in which your collection is situated?

    _____

20. Is any form of cooling system used within any part of the enclosure eg misting spray (Please state were in the enclosure it is used)

_____

_____

Feeding

21. Please list the diet fed (with the weight of each item in grams) to a single red panda at your collection. Provide a diet sheet as a separate attachment.

22. Are any variations made to the diet for the following reasons? Please give details.

Season

_____

_____

Breeding

_____

_____

Lactation

_____

_____

Young Present

_____

_____

Juvenile's

_____

_____

23. How often are The red pandas fed?

☐ Once a day ☐ Twice a day ☐ Three times a day

☐ Other _____

24. How many feed stations are present?

☐ 1 ☐ 2 ☐ 3 ☐ 4+

25. How often is bamboo fed?

☐ Every day ☐ Every other day ☐ Once a week

☐ Other _____

26. What species of bamboo, if known, is fed? _____

_____

Behaviour

27. How often is aggression observed?

☐ Never ☐ Rarely ☐ Occasionally

☐ Often ☐ Frequently and is a problem

28. Is aggression linked to any situation?

☐ Feeding ☐ Sexual activity ☐ Competition for resting sites

☐ Introduction / re-introduction of animals ☐ Other _____

29. Who leads the aggression?

☐ Male ☐ Female

☐ Older animal ☐ Younger animal ☐ Other _____

Breeding

30. If red pandas have bred within your collection is there a favoured nesting site? Please give details: _____

_____

31. Are any changes in management made for red pandas during the breeding season (e.g. restricted visitor viewing, minimal keeper disturbance etc)? Please give details:

_____

_____

_____

32. Have you ever had to hand rear red pandas? ☐ Yes ☐ No

33. Under what circumstances was there a need to hand rear?

☐ Disturbance of female ☐ Female neglect

☐ First litter ☐ Other _____

Veterinary/Health/Parasitic problems

34. Have you encountered any specific health related problems within The red pandas held in your collection e.g. Parasitic, Viral, Hair loss etc? Please give details ;

_____

_____

35. For the health related problems listed above what treatments are administered?

_____

_____

36. Have you experienced neonatal death in any of the litters born within your collection? Please give possible factors resulting in neonatal death eg disturbance of dam etc

_____

37. Please include any useful comments on the husbandry, management or medical problems related to the captive welfare of red panda.

_____

_____

_____

_____

_____

_____

_____

Many thanks for taking the time to answer this survey.