

News and Views from the Zoo Research Group

BIAZA Research Awards

The 2006 BIAZA Research Award was won by the Marwell Preservation Trust for a project on the genetics of the scimitar-horned oryx. Three commendations were also awarded: to Bristol Zoo Gardens for research into the jump-yip display and response behaviour in a captive colony of black-tailed prairie dogs; to ZSL for development of conservation tools for determining genetic relatedness in group managed species and to Paignton Zoo Environmental Park for research into the response of grey duikers to conspecific faecal deposits and possible territorial implications. Congratulations for all these excellent research projects, abstracts of each one are included in this newsletter. It was good to see that the judges felt there were enough high quality entries to award the maximum of three commendations this year.

BIAZA 9th Annual Symposium on Zoo Research

The 2007 annual research symposium will take place at Whipsnade Wild Animal Park on 23rd and 24th July. As usual all zoo-based researchers are welcome and are encouraged to offer talks or posters. The cost will be kept as low as possible. In previous years the symposium has been well attended by university students and academics but few zoos have been represented, so zoo staff are particularly encouraged to take part this year. As usual during the symposium there will be a methods workshop and this year the subject will be multi-zoo research. Further information will be available shortly, please contact Andy Hartley (andy.hartley@zsl.org) to be added to the distribution list.

BIAZA resources for zoo researchers

In addition to the Research Guidelines series the BIAZA website research section will shortly include a range of valuable information for students, including where to look to find material already available before contacting zoos about their research and details of the new BIAZA support scheme for student research projects. Under this scheme letters of support may be awarded to students to three different levels to assist zoos in their decision as to whether to become involved with the project. We urge all prospective zoo researchers to look at the site before starting research. We would also encourage zoos to recommend the website to all potential researchers contacting them.

BIAZA Research Group Resources

The following resources can be downloaded without charge from the BIAZA website (www.biaza.org.uk):

- Previous issues of Zoo Research News
- Zoo Research Guidelines: Project Planning and Behavioural Observations. Wehnelt, S., Hosie, C., Plowman, A. and Feistner, A. 2003.
- Zoo Research Guidelines: Monitoring Stress in Zoo Animals. Smith, T.E. 2004.
- Zoo Research Guidelines: Studies of the Effects of Human Visitors on Zoo Animal Behaviour. Mitchell, H. and Hosey, G. 2005.
- Zoo Research Guidelines: Sampling Guidelines for Zoos. BIAZA. 2002.
- Zoo Research Guidelines: Statistics for Typical Zoo Datasets. Plowman, A. (ed.) 2006.
- Zoo Research Guidelines: Surveys and Questionnaires. Plowman, A, Hosey, G. and Stevenson, M. 2006

The following resources are also available from the BIAZA office (there may be a small charge).

- Abstracts of the 1st Annual Symposium on Zoo Research. Plowman, AB (ed.) 1999
- Proceedings of the 2nd Annual Symposium on Zoo Research. Plowman, AB (ed.) 2000
- Proceedings of the 3rd Annual Symposium on Zoo Research. Wehnelt, S and Hudson, C (eds.) 2001
- Proceedings of the 4th Annual Symposium on Zoo Research. Dow, S (ed.) 2003
- Proceedings of the 5th Annual Symposium on Zoo Research. Gilbert, T (ed.) 2003
- Proceedings of the 6th Annual Symposium on Zoo Research. McDonald, C. (ed.) 2004
- Proceedings of the 7th Annual Symposium on Zoo Research. Nicklin, A. (ed.) 2005
- Proceedings of the 8th Annual Symposium on Zoo Research. Dow, S and Clark, F, (eds.) 2006 (due shortly)
- A database of browse use in British and Irish Zoos and poisonous plants information (CD, 2001). Plowman, A.B. and Turner, I.
- A Bibliography of References to Husbandry and Veterinary Guidelines for Animals in Zoological Collections. Macdonald, A.A. and Charlton, N. (eds.) 2000

Nutritional adequacy of gorilla diets in EEP facilities

Anna Westbury, K.A. Doernath Aguirre Alvarez and Ellen S. Dierenfeld, St Louis Zoo

Introduction

Gorillas have been kept in zoos since the late 19th Century (Vevers 1976) but their husbandry is troublesome and the first captive birth was not until 1956 at Columbus Zoo, Ohio (Cousins, 1990). There has been an International Gorilla Studbook since the 1970s and a comprehensive SSP husbandry manual since 1997 (Ogden and Wharton 1997) including a chapter on nutrition based on a survey of SSP gorilla holding facilities (Popovich and Dierenfeld 1997). Wild gorillas eat a wide range of plant matter, are seasonally frugivorous, herbaceous and folivorous (Remis 1997, 2003) selecting approximately 100 different fruit species (e.g. Popovich and Dierenfeld 1997; Remis 1997) but also leaves, bark, stems, seeds and pith, resulting in a relatively high-fibre, low-fat diet (Popovich and Dierenfeld 1997). Gorillas obtain most of their protein from leaves and shoots, and most of their energy from high-fibre food items such as stems (Watts 1996; Popovich and Dierenfeld 1997). Health and behavioural problems in captivity can be linked to poor diets (Popovich and Dierenfeld 1997) including obesity, cardiovascular disease (McGuire *et al* 1989; Cousins 1979) and ulcerative colitis (Scott and Kremer 1975). This study aimed to determine the adequacy of diets currently fed to gorillas in 62 EEP facilities.

Materials and methods

Details of the gorilla diet were requested from all 62 EEP zoos listed in the International Gorilla Studbook (Hilsberg and Bender 2005). Responses were obtained from 20 zoos but 10 were rejected as unusable due to poor quality information. The data from 10 zoos were usable giving information on 17 individual diets which were entered into Zootrition. In addition, five-day dietary intake studies were carried out at two EEP zoos to compare given and consumed diets. Data are presented on a Dry Matter basis and only data generated by Zootrition using over 80% of dietary constituents was used in calculations.

Results

Broadly across the 10 EEP zoos gorilla diets were high in fruit and animal products compared with the SSP recommendations (Table 1)

	Mean from Survey	SSP Suggested
Fruits (%)	18.95	10.00
Vegetables (%)	45.13	40.00
Greens/browse (%)	23.66	25.00
Pellets (%)	2.42	23.00
Cereal/grains/nuts (%)	3.25	2.00
Animal products (%)	6.58	0.00
Supplements (%)	0.01	

Table 1. Dietary components in surveyed gorilla diets compared to SSP recommended values (Popovich and Dierenfeld 1997).

Dietary intake studies in two zoos indicated that the gorillas consumed 93% and 100% of the diet offered suggesting that analysis based on offered diets is a reasonably accurate estimation of actual diet. Nutrient concentrations of the diets were highly variable across zoos and many did not meet the recommended concentrations for several nutrients (Table 2).

Conclusions

1. Calculated calorie intake for adult male (150 kg) and female (100 kg) gorillas averaged 5000 kcal and 2800 kcal, respectively, approximately 1.5 X basal metabolic rate as determined by generic energetics equations for mammals. This is less than the recommended guidelines which, therefore, appear to overestimate energy needs.
2. Dietary fibre content was considerably lower, and fat content higher, than those recommended based on natural foods eaten by wild gorillas, as well as guidelines suggested in the SSP Gorilla Husbandry Manual. Low fibre and high fat could both contribute to obesity, high cholesterol and cardiovascular disease. Cousins (1979) notes that cardiac arrest, associated with a poor diet and lack of exercise, is an important cause of adult gorilla deaths in captivity, particularly if fats are derived from animal sources, such as cheese as in some of the zoos. Therefore the reasons for including animal products in captive gorilla diets require careful review.
3. Calculated dietary levels of (particularly) water-soluble vitamins and trace minerals were excessive compared to estimated requirements for gorillas, whereas macromineral concentrations were only just adequate. These could be improved by increasing the proportion of pellets in the diets which is very low compared to the recommended amounts. Alternatively a clear assessment of the need for specific products used for supplementing diets is suggested to ensure optimal balance of vitamins and minerals.

4. Information on actual weight, body condition and health parameters together with detailed diet assessments is recommended for optimising gorilla diets.

Table 2. Mean, SD, maximum and minimum values for nutrients in gorilla diets of 10 EEP zoos and recommended values (converted from Allen and Oftedal 1996; Popovich et al 1997; National Research Council 2003).

Nutrient	Units	Recommended	Mean	SD	Max	Min
Energy (Male)	Kcal/d	6000	4967.02	2348.56	9540.15	2988.61
Energy (Female)	Kcal/d	4430	2762.55	715.48	3964.79	1935.1
ADF	%	23.7-52	5.67	7.69	26.64	1.44
NDF	%	33.6-73.2	9.02	13.61	46.19	1.61
Total Dietary Fibre	%	31.5	10.26	51.92	20.87	3.55
Crude Fat	%		6.97	4.60	14.63	1.92
Linoleic Acid	g/d	14.5	23.82	24.68	96.95	3.75
Linolenic Acid	g/d	1.35	2.71	1.11	5.45	1.36
Crude Protein	%		12.60	2.39	15.74	8.19
Folacin	mg/d	0.4	3.13	1.33	5.36	0.65
Niacin	mg/d	15	53.49	28.99	130.43	21.57
Pantothenic Acid	mg/d	5	25.18	10.61	46.5	6.73
Riboflavin	mg/d	1.2	7.97	6.33	24.6	2.62
Thiamin	mg/d	1.15	7.01	2.47	12.67	3.22
Vitamin A	µg/d	800	1273571.50	1452719.40	6531677.5	112902.98
Vitamin B 12	µg/d	2.4	10.41	10.09	28.43	0
Vitamin B 6	mg/d	1.3	9.99	4.43	20.97	4.01
Vitamin C	mg/d	82.5	1398.06	495.55	2052.94	139.8
Vitamin E	mg/d	15	48.92	29.32	121	0
Calcium	g/d	1.15	1.60	3.10	12.45	0.14
Copper	mg/d	0.90	14.47	13.67	53.93	3.18
Iodine	mg/d	0.15	0.15	0.13	0.35	0
Iron	mg/d	13	107.78	90.94	329.77	19.02
Magnesium	g/d	0.37	0.51	0.92	3.6	0.04
Manganese	mg/d	2.05	40.09	32.23	117.94	8.31
Phosphorus	g/d	0.7	1.22	2.01	7.75	0.16
Selenium	mg/d	0.055	0.16	0.14	0.68	0.05
Sodium	%	0.25-0.65	0.21	0.12	4.15	0.13
Zinc	mg/d	9.5	45.21	28.46	112.93	13.13

References

- Allen ME and Oftedal OT 1996 In Kleiman *et al* (eds.) *Wild Mammals in Captivity*, University of Chicago Press, pp 117-128
- Cousins D 1979 *International Zoo News* 30: 5-17
- Cousins D 1990 *The Magnificent Gorilla: The Life History of a Great Ape*, The Book Guild Ltd.
- Hilsberg S, Bender U 2005 *International Register and Studbook for the Gorilla* Frankfurt Zoological Garden
- McGuire JT, Dierenfeld ES, Poppenga RH, Braselton WE 1989 *J Med Primatol*, 18: 155-161
- National Research Council 2003 *Nutrient Requirements of Nonhuman Primates: 2nd Revised Ed.* National Academies Press
- Ogden J and Wharton D (eds) 1997 *Management of Gorillas in Captivity, Gorilla Species Survival Plan*, AZA
- Popovich DG and Dierenfeld ES 1997 In Ogden & Wharton (eds) *Management of Gorillas in Captivity, Gorilla Species Survival Plan*. AZA
- Popovich DG, Jenkins DJA, Kendall CWC, Dierenfeld ES, Carroll RW, Tariq N and Vidgen E 1997 *J Nutr*, 127: 2000-2005
- Remis MJ 1997 *Am J Primatol*, 43: 87-109
- Remis MJ 2003 In Taylor & Goldsmith (eds) *Gorilla Biology: A Multidisciplinary Perspective*. Cambridge University Press, pp 395-404
- Scott GBD and Kremer IF 1975 *Journal of Pathology* 115: 241-244
- Vevers G (1976) *London's Zoo*. Bodley Head Publishing, p 91
- Watts DP (1996) In McGrew *et al* (eds), *Great Ape Societies*. Cambridge University Press, pp 16-28

Further info: Anna Westbury, email: anna_westbury@yahoo.co.uk

Research Snippets

2006 BIAZA Research Award Winner

Genetics of the scimitar-horned oryx

A. Iyengar¹, T. Gilbert^{1,2}, T. Woodfine² and N. Mclean¹, ¹University of Southampton and ²Marwell Conservation

Once widespread and abundant across the Saharan region, the scimitar-horned oryx is now extinct in the wild. However, from a founder population of around 40 animals, there are now several thousand in captivity. Moreover, a dozen former range states have declared their interest in returning the oryx to its former habitat and prospects for reintroduction are good. Releases in fenced areas of Tunisia, Morocco and Senegal have shown encouraging results over relatively short periods of time, but all with limited founders from captive stock. Theoretically, long term success of true reintroduction will be in part dependent on the ability of the species to adapt to natural conditions without overt human intervention. Hence, selection of appropriate genetic stock to diversify existing semi-free ranging populations and fulfill broader reintroduction goals is essential, while sound management of captive populations as a backup remains critical.

Records show that the global gene pool of scimitar-horned oryx is almost entirely represented in the European (EEP) and North American (SSP) captive populations. However, with missing or questionable data in the International Studbook, the relationship between these populations and a limited number of oryx of unknown origin elsewhere in the world requires further understanding. We explored the patterns of genetic diversity across European, North American, and other selected captive groups of oryx using microsatellite markers and mitochondrial DNA control region sequencing. This provided recommendations for captive breeding and reintroduction. Together with available data on closely related species, we were also able to report on the structure and evolution of the mitochondrial DNA control region in oryx. As a result specific recommendations for global captive management and selection of animals for reintroduction have been made, with immediate consequences for the SSP and a plan to ship oryx to Tunisia in 2007. Two publications in scientific journals have resulted from this work.

See: Iyengar A, Diniz FM, Gilbert T, Woodfine T, Knowles J & Mclean N 2006. Mol. Phylo. Evol. 40: 305 -314.

Further info: Tania Gilbert, Marwell Conservation. Tel: +44 (0)1962 777934, email: taniag@marwell.org.uk

2006 BIAZA Research Award Commendation

The jump-yip display and response behaviour in a captive colony of black-tailed prairie dogs, *Cynomys ludovicianus*

Sue Dow, Bristol Zoo Gardens and Charlotte Day, Bristol University

Black-tailed prairie dogs, *Cynomys ludovicianus*, show high rates of a behaviour pattern consisting of an upwards leap in conjunction with a two-syllable vocalisation, the “jump-yip” display. This behaviour is often contagious in eliciting further displays from individuals of home and adjacent coterie territories, although some displays do not elicit a response. This study aimed to identify reasons for this observed difference in jump-yip response elicitation by initiating callers.

Seventeen parameters of jump-yip calls were analysed from recordings of a captive zoo colony of black-tailed prairie dogs. No structural differences were found between calls that elicit a response and those which do not. Black-tailed prairie dogs were shown to respond to the vocal component of the display in isolation from the visual component in a playback experiment. They respond significantly less frequently to calls given within a short latency of a previous initiating jump-yip than to calls made after a longer latency. This supports a function of the jump-yip call as part of a system of co-ordinated vigilance within groups. A behavioural refractory period could optimise the benefits from such a system by minimising the loss of time available for non-vigilance-related behaviours. Timing did not account for all observed response differences suggesting that further factors may be important determinants of response elicitation.

Further info: Sue Dow, Bristol Zoo Gardens, Clifton, Bristol BS8 3HA. Tel: 0117 974 7304, email: sdow@bristolzoo.org.uk

2006 BIAZA Research Award Commendation

Conservation tools for determining genetic relatedness in group managed species.

Paul Pearce-Kelly, Raj Amin and Jinliang Wang, Zoological Society of London

Currently available genetic tracking and analysis software tools are reliant upon individually based pedigree information to calculate kinship among individuals. Of the nine recognised categories of species management levels only one pertains to non-group managed species. The other eight categories include the vast majority of species. As ever more species require conservation breeding assistance (e.g. the large number of amphibians facing global species declines) the group-management approach is inevitably becoming the most practical option - even

for many traditionally individual-based programmes. Therefore, there is pressing need to develop group-oriented genetic management solutions for the development of the global *Zoological Information Management System* (ZIMS) and its associated (currently individual based) demographic and genetic analysis tool PM2000.

A ZSL research team has been working in collaboration with EAZA, EADISC, ISIS and CBSG to address the most technically demanding aspect of this work. This research work has succeeded in developing the mathematical genetic model which has been validated using real species programme data (the EEP Partula snail programme). A demonstration software tool has also been developed to assist the practical implementation of the model and associated management algorithms. This in turn has led to the development (by the same research team) of a genetic relatedness visualisation tool which for the first time provides population managers with the relevant information in a clear and concise manner. This research provides a major breakthrough in the conservation of group managed species from invertebrates through to mammals.

Further info: Paul Pearce-Kelly, Zoological Society of London, Regent's Park, London. Email: Paul.Pearce-Kelly@zsl.org

2006 BIAZA Research Award Commendation

The response of grey duikers (*Sylvicapra grimmia*) to conspecific faecal deposits: possible territorial implications

Nicky Lunt and Tongai Chiradza, Marwell Zimbabwe Trust and Amy Plowman, Paignton Zoo Environmental Park

Duikers are becoming increasingly threatened, primarily due to hunting for bushmeat. In Zimbabwe, recent economic decline has led to very significant increases in bushmeat hunting and trade; possibly even to the extent to cause local extinction of the usually abundant grey duiker (N.Lunt unpubl. data). Duikers are very poorly studied and more information is needed to develop effective monitoring systems and conservation plans. Territorial behaviour is particularly important as estimates of territory size and degree of overlap are often used to determine density of individuals. Dambari is the headquarters of the Marwell Zimbabwe Trust and holds a large collection of small antelope including many grey duiker. It provides an ideal situation to test hypotheses about these small, secretive animals in semi-natural conditions. Grey duikers (Cephalophini: *Sylvicapra grimmia*) are territorial antelope that use olfactory means to demarcate territorial boundaries. The role of faeces in territorial behaviour was investigated using semi-captive antelope at Dambari Field Station, Zimbabwe. The strength of response to introduced faecal deposits of various ages from unfamiliar conspecifics of both sexes and three age classes was measured using a repeated measures design. Latrine sites, faecal pile dry mass and defecation rates did not alter with introduction of unfamiliar faecal piles, and fresh mass of introduced faeces did not affect response magnitude. Dung of intermediate age elicited the greatest response, and animals responded most intensely to the dung of animals in their prime. Adult male and female response frequency was not statistically different, although males responded to fresher dung than did females and only adult males scent-marked near introduced deposits. Adults showed greater interest in introductions than juveniles. It is concluded that faecal piles act as both olfactory and visual signals, and that the differences between sexes in the types and magnitude of response are related to territorial behaviour.

Improving zoo enclosures may make visitors care less

Amy Plowman, Whitley Wildlife Conservation Trust

Conservation education is a major role of zoos but there is little evidence that this is benefited by new, and often very expensive, zoo exhibits. Thus, a visitor survey was conducted to evaluate the effects of the new Monkey Heights exhibit, opened at Paignton Zoo in 2005. Visitors to the old monkey house and to the new exhibit were questioned on their feelings towards monkeys, their perception of the monkeys' welfare, their concern for conservation of monkeys and their natural habitats and their willingness to undertake certain conservation actions. The vast majority of visitors to both exhibits had positive feelings about monkeys and there was no significant difference between the exhibits in this respect. Not surprisingly, significantly more visitors to the new exhibit believed the monkeys to have high standards of welfare than visitors to the old exhibit; e.g. in Monkey Heights 32% strongly agreed the monkeys looked 'happy' compared with 3% in the old exhibit ($\chi^2_{[3]} = 23.22$, $p < 0.001$). However, visitors to Monkey Heights were less concerned about monkey conservation and less likely to undertake conservation action than visitors to the old exhibit; e.g. in the old house 81% of visitors strongly agreed that it was important for monkeys to survive in the wild, compared with 48% in the new exhibit ($\chi^2_{[1]} = 18.35$, $p < 0.001$), and 24% of visitors in the old exhibit said they were very likely to avoid buying non-sustainable tropical timber compared with 8% in the new exhibit ($\chi^2_{[3]} = 15.53$, $p < 0.01$). It seems that improving zoo animal welfare (or at least the perception of it) may have detrimental affects on zoos' ability to encourage visitors to care about and take action for animal conservation.

Further info on both the above: Amy Plowman, Paignton Zoo. Tel: 01803 697514, email: amy.plowman@paigntonzoo.org.uk

Visitor awareness of native species within Paignton Zoo

Katherine Thomas and Dave Price, University of Plymouth and Natasha de Vere, Whitley Wildlife Conservation Trust

Zoos are one of the main locations where people in the UK are able to come into contact with exotic animals. However, they may also provide opportunities for visitors to encounter native species. At Paignton Zoo Environmental Park, South Devon an interview-based questionnaire showed that less than 50% of visitors were aware of the Clennon Gorge nature trail, sited within the Zoo. Knowledge was largely influenced by the distance travelled to the zoo and the number of previous visits that had been made. The majority of visitors gave time constraints as the main reason for not visiting the nature trail. Along the nature trail the number of native bird species seen by visitors correlated with the interest rating of visitors, the length of time the visitor had been at the zoo, and the rank of the species on the BTO bird watch count. No relationship was found between the gender and group structure of visitors and the amount of information wanted about native species. However, a difference was found in relation to visitor age. Approximately two-thirds of visitors said they would like to see more information on native species. The preferred location of this information differed in relation to visitor age, gender and whether or not they were members of Paignton Zoo. With the exception of visitors aged 56+, information posted around the zoo was the preferred option holding approximately 35% of the vote. The study indicates that more could be done to educate visitors about native species that exist within and around the zoo. Enhanced knowledge may be needed of the location of native species within the zoo and the nature of their interactions with exotic species to do this

Further info: Natasha de Vere, Whitley Wildlife Conservation Trust, Paignton Zoo, Totnes Road, Paignton, Devon TQ4 7EU, U.K. Tel: 01803 697514, fax: 01803 523457, email: natasha.devere@paigntonzoo.org.uk

Announcements

Primate Society of Great Britain Captive Care Grants

The PSGB Captive Care Working Party is looking for submissions for Captive Care Grants. These are awards, typically not exceeding £750, to assist research of benefit to primate welfare in captivity and primate welfare education. The application deadline for this year is 31st March 2007. More details can be found at www.psgb.org/CaptiveCare/index.html

Public perceptions of carnivore feeding methods survey – request for participants

At the 7th International Conference on Environmental Enrichment (ICEE), New York, a number of authors contributed to the symposium 'To carcass or not?' organised by Dr Vicky Melfi to discuss the benefits and problems associated with providing carcasses for zoo carnivores. Research suggests that carcass provision for carnivores is beneficial, promoting natural behaviour, reducing abnormal behaviour and is not detrimental to health (see Feature Article). However, carcass feeding is not implemented worldwide. It has been suggested that public perception of carcass feeding may differ internationally, resulting in some zoos being hesitant about using this method of feeding despite it being extremely beneficial. At the ICEE symposium it was suggested that an international survey be undertaken to evaluate zoo visitors' perceptions of carcass feeding. Such a survey has now been created and we are seeking collaborators to carry it out in zoos worldwide, following a standard protocol. The aims of the survey were presented at the Australasian Regional Environmental Enrichment Conference in November 2006 and many Australian, New Zealand and South-East Asian zoos have already agreed to take part. If you are able to assist please contact Kathy Knight (kathy.knight@paigntonzoo.org.uk) or Vicky Melfi (vicky.melfi@paigntonzoo.org.uk). Tel: +44 (0)1803 697514.

8th International Conference on Environmental Enrichment, 5-10 August, 2007

The 8th International Conference on Environmental Enrichment will be hosted by Schoenbrunn Zoo at the Austria Trend Parkhotel Schoenbrunn, Vienna, Austria. See the conference website www.zoovienna.at/icee2007 for details.

EAZA Research Conference 2007, 24-25 May 2007

EAZA, Poznan Zoological Garden and the University of Adam Mickiewicz at Poznan invite you to participate in the EAZA Research Conference 2007, in Poznan, Poland. The conference is aimed at zoo as well as university staff and students. The conference language will be English. Oral presentations and posters will be accepted on research done in or by zoos, rescue centres or scientific collections. Titles and abstracts should be submitted by 15 March 2007. Contact conference@op.pl or check <http://www.eaza.net/news/1calendar.html> for more details

Your contributions are needed

Please send articles, announcements, comments or other feedback for the next issue by the end of December to:

Dr Amy Plowman, Paignton Zoo Environmental Park, Totnes Road, Paignton, Devon TQ4 7EU, U.K.

Tel: 01803 697514, fax: 01803 523457, email: amy.plowman@paigntonzoo.org.uk