Zoo Nutrition News

September 2001

Photo: Rob Doolaard/IZP

Contents

SPECIAL ISSUE 2

Second European Zoo Nutrition Meeting

From the Organising Committee

Dear member,

Sadly, after some twelve months of detailed planning, we were forced to cancel the 2nd European Nutrition Conference, because of the outbreak of Foot & Mouth Disease in parts of the United Kingdom. Despite the fact that Hampshire and neighbouring counties remained free of the disease, the number of delegates who were compelled by their respective institutions to cancel their registration steadily increased, and the subsequent outbreak of the disease in Germany, France and The Netherlands saw this number rise very significantly.

In view of this situation, the decision to cancel was taken to protect the principle organising institution, Marwell Zoological Park, from any financial loss, and also to ensure that all delegates could receive a refund. The latter would not have been the case had we proceeded with the conference since all costs were based on guaranteeing at least 90-100 delegates. Neither was deferment of the conference a realistic option, given the level of uncertainty that surrounded how long the outbreak would last and clashes with other zoo meetings planned for the end of the year.

A special meeting was hastily convened at the Sparsholt Agricultural College, near Winchester, during the period that the Nutrition Conference would have been held. Attended by the principle organisers and several other interested parties, this meeting discussed the dissemination of the conference material, of which this newsletter forms a part, and also considered the possibility of forming a dedicated group within EAZA to advance the study of nutrition in European Zoos.

The programme intended for the Second Conference (pp 18-19) promised to be diverse, stimulating and as informative as the First European Zoo Nutrition Conference held in Rotterdam in 1999. The quantity and range of articles submitted also demonstrates that zoo animal nutrition requires a forum in Europe. All contributors agreed to their abstracts being published and everyone who registered will receive their copy of the abstract book shortly (see page 28 to obtain additional copies). A volume of conference proceedings will also be published next summer and proceedings from the previous meeting are still available as Volume 1 of Zoo Animal Nutrition (page 28). In publishing these articles of practical interest to all zoos, and at a later stage the agenda and the full proceedings, we very much hope to maintain the momentum generated by the first meeting.

Where better to start than with a perspective on the potential for advancing zoo nutrition world-wide? A review of the coverage given to nutrition within European breeding programme husbandry manuals follows, identifying the knowledge gaps and ways that zoo nutritionists can help. Being hosted by Marwell Zoo, a strong ungulate theme ran through the conference programme. Adequate feeding of these species is a major challenge in zoos, and Zurich Zoo describe the process involved in producing browse silage. Browse is fed to many species other than ungulates, although it is often difficult to know what's best for different animals. A database of mammalian browse use compiled for British zoos is described, and there's a brief discussion of the basis on which a 'global' browse database is currently being constructed.

Dutch zoos have joined forces to exchange dietary information using ZOOTRITION™ as a software tool. However, the output generated is only as good as the information available and recent work at Bristol Zoo Gardens highlights some practical problems collected zoo diet data. Another common perception when feeding is that zoo animals have 'nutritional wisdom', so is cafeteria-style feeding really the best option? The final article has a novel twist – should we be using zoo diets to educate visitors about what animals eat in the wild? It seems they might need a little help. The closing remarks take us full circle from the idea of advancing zoo nutrition world-wide, to the role European zoos can play, through the formation of the European Zoo Nutrition Research Group and plans to establish an European Zoo Nutrition Research Centre – both extremely exciting projects!

Although the Marwell meeting could not be rescheduled, we are pleased to announce the Joint Nutrition Symposium being held in Antwerp, in August 2002. This will be an international meeting of the Comparative Nutrition Society, the European Society of Veterinary and Comparative Nutrition and the European Zoo Nutrition Research Group. For more details see page 17.

Many thanks to the EAZA Executive Office for their assistance and also to Marcus Clauss, Helena Marquès and Joeke Nijboer for their editorial contributions in compiling this second special Nutrition issue. It would have not been possible to produce this newsletter without the assistance of our sponsors, information about whom is also displayed in this special edition, and we extend our gratitude for their support.

Peter Bircher, Marwell Preservation Trust
and Andrea Fidgett, University of Glasgow
Members of Organising Committee of Second European Zoo Nutrition Conference

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COLOPHON

EAZA News is the quarterly magazine of The European Association of Zoos and Aquaria (EAZA)

This special issue of EAZA News is dedicated to Zoo Nutrition and was compiled as a result of the Second European Zoo Nutrition Meeting cancelled in the United Kingdom because of Footh & Mouth Disease, 2001.

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Advancing zoo nutrition through global synergy

by Ellen S. Dierenfeld, Wildlife Conservation Society, USA

The formalisation of the AZA Nutrition Advisory Group (NAG) was an important step in the recognition of nutrition as an essential disciplinary specialty of zoo biology. An international synergy that underlies the rapid progress of the field emerged at the organisation's first conference. By 1998, recognising the importance of global communication, the NAG incorporated an International Liaison position to its Executive Committee and currently has members from 14 countries.
The NAGNOTES listserve and a recently created web site www.nagonline.net provide global communications conduits and electronic gateways to contacts, references, and nutrition information.

Despite the AZA and EAZA joint emphasis on scientifically based animal management, integration within the discipline of nutrition is relatively recent. Zoo nutrition is by nature multi-national as well as multi-disciplinary, encompassing feedstuff management, animal husbandry, physiology and anatomy. Consequently, expansion must be addressed internationally through both applied and basic research initiatives. Aspects of feed/food management have been well defined by industry, research, and government regulatory personnel in many countries. Much of this information is also available free of charge through the Internet. To avoid duplication and maintain up-to-date standards, materials such as Fact Sheets and/or relevant websites covering these topics need to be identified, reviewed, and linked through proper portals for use by the zoo community. An appropriate site for widespread information distribution of this type may be the NAG home page. Another location that already contains basic food handling and storage protocols is the Zoo Conservation Outreach Group web site (www.zcog.org), where Latin American zoo professionals can access information in native languages. Plans are underway to translate original documents, with local wildlife diet examples, for application to SE Asian facilities through a web interface.

The creation of joint recommendations and reference libraries for describing dietary husbandry of targeted EEP/SSP or TAG programs is another means of advancing global synergy. Within recent years, AZA/EAZA co-authored materials have been initiated for a number of species including okapi, babirusa, callithrichids, rhinoceros, and various avian groups. Including range-country nutrition advisors in species management groups enhances information exchange, training, and *in situ* conservation opportunities. Tools for standardised recommendations and evaluation need to be developed and made readily available for most effective implementation. Outlines established by the NAG for nutrition husbandry chapter formats and review, as well as the European Zoo Nutrition Research Group's creation of a European Zoo Diet Database, are examples of such initiatives. Through integration and summary of existing information in a systematic manner, we can identify gaps in knowledge and concentrate our limited resources on filling 'black holes'.

Joint development of accessible databases of Food Composition, Diet Evaluation, Nutrient Recommendations, and Physiological Assessment of Nutritional Status provides further information exchange. Database development working groups have been established within the NAG and IUCN's Conservation Breeding Specialist Group; global browse and whole prey projects are ongoing (Boardman and Dierenfeld, 2001; Dierenfeld *et al.*, 2001; Irlbeck *et al.*, 2001). WILDPro[R] www.wildlifeinformation.org, an electronic encyclopaedia of wildlife health and management, provides one example of an outlet for networked nutrition data targeted at health professionals as well as the rehabilitation/reintroduction communities with whom nutritionists interact. Linking information via an electronic framework will also promote more rapid merging with interdependent disciplines such as reproduction, immunology, and genetics.

Photo: WCS

Advancing Zoo Nutrition

Training programs that emphasise comparative nutrition must be supported, through scholarship, internship, residency, and international exchange opportunities. No specific academic programs, scientific disciplinary qualifications, nor licensure examinations have been established for zoo nutritionists that standardise training or support professional advancement; this may be an arena for joint focus by EAZA/AZA nutrition specialists. Food Safety and Handling certification, required for human restaurant/kitchen management, has been suggested as a future criterion of AZA accreditation. Zoo nutrition groups can proactively address this issue through credentialed workshops which highlight the importance of managed feeding programs and differentiate the speciality roles of food service managers from those of nutritionists.

Photo: WCS

Zootrition™ dietary management software provides a final example of dynamic synergy. The program was based upon content suggestions from contributors in eight countries, beta-tested in five countries, and currently has users in 34 countries. Zootrition 2, anticipated for release in late 2001, contains expanded database information and comparative functions, an energetics module, data log templates, integrated reference sections, and a more intuitive interface – resulting from user feedback with advice from multinational expert consultants. Designed for a network environment, Zootrition 2 accommodates up to 30 users for training purposes and provides data exchange capabilities via Internet. Improved interface with existing medical (MedARKS) and animal demographics (ARKS) records-keeping software remains a continuing goal of Zootrition.

Such improvements result directly from the shared vision of the zoo nutrition and conservation communities. AZA's NAG identified the development of standardised records-keeping software as a priority in its 5-year plan in the mid-1990s, allowing successful upgrade funding opportunities through the Conservation Endowment Fund. Zootrition was adopted as the national standard by the Dutch Federation of Zoos in 1999, and a national project to create a combined database of feedstuffs and diets was undertaken (see Nijboer, this volume). In 2000 the Colombian Zoo Association, with support from ZCOG, provided Zootrition software and a training workshop to its constituent facilities, and Latin American databases are under creation for incorporation into future upgrades. As a means of ensuring integrated and continued development of Zootrition, the Wildlife Conservation Society anticipates creation of an international oversight board to direct its future expansion, in addition to networked regional centres for diet and ingredient data curation/validation.

The rapid assimilation of many specific issues, detailed and discussed over the years (Dierenfeld, 1993), as current standards within the field of zoo nutrition is particularly gratifying. Given today's electronic communications capabilities, it is clear that anything that can be envisioned can likely be realised.

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The status of Nutrition within European Breeding Programme Husbandry Guidelines – can we help?

by Andrea Fidgett, University of Glasgow, United Kingdom;
Joeke Nijboer and Wim van der Horst, Rotterdam Zoo,
The Netherlands; Jean-Michel Hatt, University of Zurich, Switzerland
and Alastair Macdonald, University of Edinburgh, United Kingdom

Many modern zoos have agreed to work together, focussing their conservation efforts on endangered species and establishing breeding programs for these animals. In Europe these projects are called EEPs (European Endangered Breeding Programmes) and one of the responsibilities of EEP coordinators is to develop husbandry guidelines, aiming to achieve optimal conditions for well-being and reproduction of all the animals in the programme. An essential component of any animal,s husbandry is what it should be fed and guidelines must therefore contain a section on feeding, summarising the diet consumed both in situ and ex situ in terms of the nutrients present (i.e., how much protein, carbohydrate, fat and 'fibre'). Additional sections should list any special dietary requirements, handrearing protocols, nutrition-related health problems and a bibliography.

A preliminary investigation of EEP guidelines available in August 2000, found that less than half presented adequate advice on the nutrient requirement of the species. A questionnaire was devised to gather up-to-date information on how many husbandry manuals have been published, whether they contain sections about diet and nutrition and stimulate their improvement by encouraging the inclusion of nutritional information in a standardised format. The questionnaire was sent to the Coordinator or Chair of the 126 EEPs, 68 approved European Stud Books (ESBs) and 32 Taxon Advisory Groups (TAGs) listed in the 1989/99 EEP Yearbook. Many coordinators have already asked for support in compiling the nutrition section of guidelines and the information collated from the questionnaire would reveal where the major gaps in nutritional knowledge lie.

Responses

Completed questionnaires were received from 66% of all EEP coordinators, 15% of ESB holders and 50% of TAG chair people (Figure 1). From their responses, there were a total of 58 husbandry guidelines; 48 for EEPs, 3 for ESBs and 7 for TAGs (38%, 4% and 22% respectively of the total programmes listed in the EEP Yearbook). There were also 20 guidelines in various stages of preparation, although the data in this article is based on published guidelines.

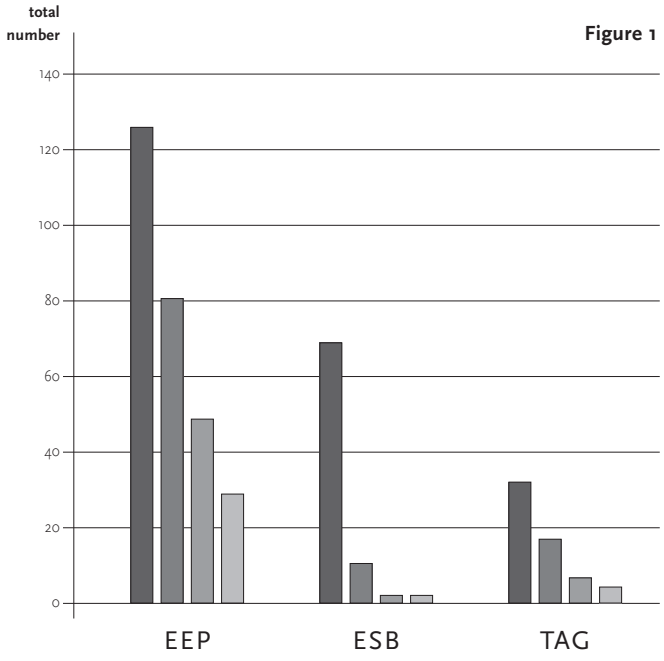

Figure 1

Figure 1 The relationship between the total number of EAZA coordinated projects, questionnaire replies, published husbandry guidelines and nutrition sections within those guidelines.

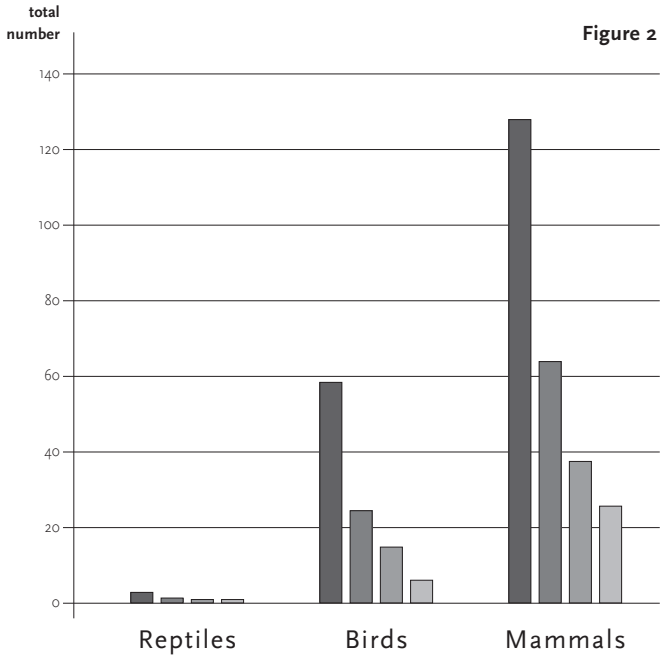

Figure 2

Figure 2 Questionnaire replies grouped by taxa, showing the relationship between the total number of EAZA coordinated projects, questionnaire replies, published husbandry guidelines and nutrition sections within those guidelines.

Nutrition chapter status

In response to the question 'Do your husbandry guidelines contain a nutrition section?', 65% of EEPs, 100% of ESBs and 71% of the TAGs said they did. The precise nature of the information within the nutrition section varied considerably in content (Table 1).
Far fewer guidelines were produced by ESBs and TAGs, although they were more likely to have information under most of the eight subsections listed in the questionnaire.

	EEP	ESB	TAG
No. of Guidelines published (as % of all programmes)	48 (38%)	3 (4%)	7 (22%)
No. of Guidelines with Nutrition sections	31	3	5
Sections present:			
Feeding schedule	24	3	4
Nutrient content of diet	19	2	4
Diet & feeding information	28	3	4
Hand-rearing protocol	22	2	2
Nutrient requirements/recommendations	22	2	3
Health or other problems associated with diet	19	2	3
Description of natural diet composition	15	2	3
Bibliography of references relating to natural diet	13	2	4

Table 1 The structure of nutrition sections within husbandry guidelines, grouped according to programme type. The section headings are based on a format recommended by the Nutrition Advisory Group of AZA.

Looking just at EEP and ESB guidelines (since some of this information was duplicated by TAG guidelines) almost all, (91%), contained information about the food items and quantities fed in captivity, but only two thirds presented a nutrient breakdown of the captive diet and just 50% have a section about the wild diet, describing wild food items and their nutrient composition. Only 15 replies (39%) indicated satisfaction with the nutrition section. A nutrition advisor was consulted in 12 instances (35% of all nutrition sections) and two thirds of the respondents would like access to a consultant in order to improve the guidelines.

Grouping the EEP/ESBs by taxa, approximately 50-55% of all the reptile, bird and mammal programmes that replied had published husbandry guidelines. However, a higher proportion of reptile and mammal husbandry guidelines contained nutrition sections than publications for bird species (see Figure 2). Furthermore, bird nutrition sections contained very little information about the nutrient content of either the captive or wild diet although, perhaps not surprisingly, they all had information about hand-rearing protocols.

One of the first activities of the newly-formed European Zoo Nutrition Research Group will be to schedule nutrition workshops and help sessions during the 2001 EAZA Conference in Prague. Furthermore, Species Survival Programmes (SSPs), the North American equivalent to EEPs, are currently undergoing a similar review process and the results from both studies will be compared to determine areas of information overlap, deficiency and potential exchange of expertise.

Nutrition isn't everything, but...

Investigating the nutrition of EEP species may ultimately have a wider impact within the zoo community. Nearly all zoos spend approximately 3-6% of their budget on food for their animals. More attention devoted to the ingredients being fed could reduce these costs and improve the nutrition, mainly by simplifying the diet. Feeding a smaller range of items will often result in a better and more consistently balanced diet and ultimately, less obese zoo animals. Simplification of diets will reduce the amount of labour involved in food preparation, which may reduce expenditure but will also free up time for keepers to devote to other important aspects of animal husbandry, enrichment for example. Many forms of enrichment for captive animals involve novel means of food presentation, often derived from behaviours that have been observed in their wild counterparts. Therefore a 'simple' diet, e.g. of just pellets and hay for an ungulate, would not be considered satisfactory without due consideration of how to meet the species' physiological *and* psychological requirements.

Zoos currently focus much of their research, conservation and husbandry effort on species included in EEP, ESB and TAG programmes – these are our 'target' species. If, as it appears from this review, there are still too few husbandry guidelines and fewer still containing the information we need to formulate adequate diets for these species in captivity, then its likely that our knowledge of the remaining species in our care is much worse. There is clearly a lot of work still to be done.

Browse silage in zoo animal nutrition – feeding enrichment of browsers during winter

by Jean-Michel Hatt, University of Zurich, Switzerland and Marcus Clauss, Ludwig Maximilians University, Germany

A major challenge in zoo animal nutrition is the adequate feeding of browsers, such as certain antelopes, giraffes (Giraffa camelopardalis), moose (Alces alces) or black rhinos (Diceros bicornis). The supplementation of browse in these species has been recognised to constitute an important factor in the feeding and health of these species. Whereas in spring and summer it is fairly easy to provide adequate amounts of browse, diets of these species may become unbalanced during winter months when browse is scarce. As substitutes, zoos may recur to feeding alternative feedstuffs such as apple pomace, or they may freeze or dry browse during the summer months which then can be offered in the winter. However, these methods are cost and energy intensive and may require large storing spaces which often are not available. A practical alternative is the production of browse silage, which is cheap and easy to produce. At Zurich Zoo this method has successfully been applied for five years.

Photos: Jean-Michel Hatt

1

2

3

4

Preparation of browse silage

In late spring (around late May to early June) as much available browse as possible (diameter up to 3 cm) is processed in a chaffcutter (Figure 1). The main species of browse used are willow, hazel and maple. Subsequently the browse is tightly filled into plastic containers (volume 200 l) with the help of a wooden peg (Figure 2). The containers are filled to the top (Figure 3), closed airtight (Figure 4) and stored at temperatures not higher than 20°C. No additives are added to the browse. Currently approximately 1200 kg of browse silage is produced annually with this method.

Feeding browse silage

Approximately five months later, from November onwards, the silage is fed on a daily basis to four black rhinoceros (*Diceros bicornis*), the main browsing species currently kept at Zurich Zoo. Each animal receives approximately 2 kg of browse silage per day. If the containers have not be well filled or not closed absolutely airtight, mould can develop in some areas. As the ingestion of concentrated amounts of fungi is potentially harmful, it is important that before feeding the silage be carefully inspected and the obviously contaminated silage be disposed. It is not necessary to dispose of the whole container. To date no negative effects (such as colics) of feeding browse silage to black rhinos have been observed.

1 *Fresh browse being processed in a chaffcutter at Zurich Zoo for browse silage production*

2 *After chaffcutting, the browse is tightly filled into plastic containers (200 litre volume) with the help of a wooden peg*

3 *The containers are filled to the top with the browse*

4 *Airtight closing of containers with the browse before silage process*

Gorilla

Photo: Rob Doolaard/IZP

Chemical analysis of browse silage and conclusions

Chemical analysis of the browse before and after the silage process shows no significant alteration in composition (Table 1). The silage is very popular with the black rhinoceros and represents an excellent enrichment of the diet. Furthermore it provides the animals with a variety of secondary plant compounds such as lignin or tannins which are naturally ingested by browsers in the wild and may contribute to an adequate gastrointestinal health status. The browse silage may also prove to be useful in other herbivores, such as gorillas (*Gorilla gorilla*), where the addition of browse in the diet has proven beneficial concerning the health of gastrointestinal tract and the occurrence of diarrhoea (Savini, *et al.*, 2000). Browse silage is currently not widely used. It is hoped that this practical description of the method will result in a wider distribution of browse silage and also in research concerning its effects on digestion and wellbeing.

		Before*	After*
Dry matter	%	47.8	46.8
Organic matter	% DM	96.4	96.2
Crude protein	% DM	4.9	5.3
Crude fat	% DM	1.0	1.3
Crude ash	% DM	3.6	3.8
Crude fibre	% DM	51.6	53.2
ADF	% DM	60.1	63.7
Lignin	% DM	14.7	16.6
Cellulose	% DM	45.4	47.1
Gross energy	MJ/kg DM	18.8	19.0
Calcium	% DM	0.9	0.9
Phosphorus	% DM	0.1	0.1

* Differences between data in columns are not significant

Table 1 Chemical analysis of browse (willow, hazel and maple) before and after silage process.

References

Savini, T., K. Leus and L. Van Elsacker (2000): Effects of dietary changes on the behaviour and fecal consistency of three captive Eastern lowland gorillas (*Gorilla gorilla graueri*) at the Royal Zoological Society of Antwerpen. In Zoo Animal Nutrition, 139-152. J. Nijboer, J.-M. Hatt, W. Kaumanns, A. Beijnen and U. Ganslosser (Eds). Fürth: Filander Verlag, pp. 139-152.

UK Browse database

A survey and database of browse use for mammals in UK and Irish zoos

by Amy Plowman and Ian Turner, Paignton Zoo Environmental Park, United Kingdom

Most zoos recognise that fresh browse is a beneficial, if not essential, component of successful husbandry. However, in many zoos the supply of browse is not as great as keepers would wish. This problem could be partially overcome by increasing the range of plant species approved for use as browse. This range may be limited by a lack of knowledge as to which plants are safe to use for which animals, and whether this depends on specific parts of the plant, such as fruits or bark, or on particular seasons such as during early growth in spring.

Several toxic plant lists are available and easily accessible on the world wide web. However, most of these lists only refer to toxicity to humans and domestic animals. Very few include information on toxicity to exotic animals, many of which are adapted to cope with various plant toxins in ways that humans and domestic animals are not. Thus, there is clearly a need for more information on the safety or otherwise of readily available browse species for consumption by zoo animals. Thus this database was compiled to give zoos more information on which plant species have been used successfully for certain mammals in other zoos.

Methods

A questionnaire was sent to 60 zoological gardens in Britain and Ireland. Respondents were asked to list all plants (excluding commercially supplied fruit and vegetables) eaten by mammals in their zoo, whether these were provided keepers or just available in the animals' enclosure. They were asked to specify if the whole or major part of the plant was eaten or only certain parts (e.g. leaf, flower, fruit), if there had been any adverse effects of eating the plant and to make other comments such as whether plants had good behavioural enrichment value. Several commonly occurring plant species or genera were listed on the survey forms and many zoos also added additional species.

The questionnaire requested the information mostly by mammal family; for those taxa where it was felt that browse use might vary greatly within a family e.g. between colobines and guenons, it was requested by sub-family; for those taxa where it was felt browse use would be infrequent, e.g. Carnivora, it was requested by order. In practice, many respondents also provided the genus or species name and this information has also been entered on the database.

Photo: Rob Doolaard/IZP

The data can thus be searched by animal order, family, sub-family, genus and species.

All responses to the questionnaire were entered into an Access database, including all comments and adverse effects. The database is designed so that a plant or animal search will only return the number of records for which no adverse effect was reported. Thus, if there were a total of 10 records for willow and gorillas but two had reported an adverse effect, eight records would be returned. Any adverse effects can be found by searching in that section.

Results

Completed questionnaires were returned from 21 British and Irish zoos and one continental European zoo, giving a total of 1827 plant + mammal records.

Plants used as browse

The total number of plant taxa recorded in the database as being used as browse is 113. Individual zoos use between two and 42 different browse types with a mean of 18. The average number of records per browse type is 16.2 but there is huge variation. Only 14 browse types have more than 50 records, another 12 types have between 10 and 50 records, 42 occur between two and 10 times and 45 are only listed once. Table 1 shows the top ten browse types used and their frequency of occurrence in the database.

UK Browse database

Table 1 Top ten browse types recorded in a survey of browse use for mammals in British and Irish zoos.

Scientific name	English name	Records	Scientific name	English name	Records
Salix	Willow	205	*Crataegus monogyna*	Hawthorn	93
Quercus (incl. Q. ilex)	Oak	150	*Bambusaceae*	Bamboo	80
Fraxinus	Ash	130	*Prunus*	Cherry, blackthorn etc.	77
Fagus	Beech	116	*Castanaea sativa*	Sweet chestnut	65
Acer pseudoplatanus	Sycamore	108	*Tilia*	Lime	61

Table 2 Animal orders recorded in the database of browse use for mammals in British and Irish zoos.

Order	**No. of families or sub-families**	**No. of genera or species**	**Total** Records	**No. of browse types** used
Artiodactyla	8	39	683	52
Primates	7	24	586	77
Rodentia	7	6	96	33
Perissodactyla	3	9	164	37
Marsupialia	3	4	76	31
Carnivora	3	3	28	17
Chiroptera	1	1	15	12
Proboscidea	1	2	88	45

Mammals given browse

Responses were received for eight mammal orders encompassing 33 families or sub-families and 88 genera or species (table 2). Most records were received for Artiodactyla, but the order receiving the greatest variety of browse is Primates and the least Chiroptera. The highest number of browse types used per species within an order is the Proboscidea, which probably reflects the generally accepted view that browse is especially important for elephants and the need to use many types of browse in order to provide the quantities required.

When grouped by the taxa (order, family or sub-family) requested in the original survey, elephants clearly receive the greatest variety of browse per zoo with a mean of 15, although there was a huge range with one zoo using three browse types and one zoo using 31 browse types (table 3). The groups with next highest diversity of browse used per zoo, unsurprisingly, are the great apes (probably as behavioural enrichment rather than nutritional supplement) and the giraffe/okapi. Those taxa with a low mean variety of browse types provided are, unsurprisingly, the Carnivora and various grazing herbivores and, more surprisingly, the gibbons and Callitrichids.

Table 3 Mean number and range of browse types provided at individual zoos for various mammal taxa in UK and Irish zoos.

Animal taxon	Mean no. browse types per zoo	N	Range
Elephantidae	15.0	6	3-31
Pongidae	9.3	12	2-21
Giraffidae	9.2	10	3-14
Rhinocerotidae	8.6	8	2-32
Hippopotidae	8.3	4	3-21
Bovidae: Caprinae	8.0	10	2-22
Cercopithidae: Colobinae	7.4	8	1-19
Cervidae	7.2	16	2-22
Camelidae	7.0	14	1-21
Other Cercopithidae	6.9	12	1-15
Cercopithidae: guenons	6.4	10	2-14
Cebidae	6.3	12	2-16
Marsupalia	6.3	12	2-17
Suidae/Tayassuidae	6.1	11	2-10
Tapiridae	6.1	11	2-32
Bovidae: Antilopinae	5.7	6	2-10
Bovidae: Bovinae	5.7	19	1-13
Prosimians	5.1	15	1-10
Rodentia	5.1	19	1-16
Chiroptera	5.0	3	1-7
Callitrichidae	4.8	10	1-11
Hylobatidae	4.7	11	1-12
Bovidae: Reduncinae	4.5	4	1-12
Tragulidae	4.0	2	2-6
Bovidae: Hippotraginae	3.5	10	1-11
Carnivora	3.5	8	1-10

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Adverse effects

Only 35 records (1.8%) included adverse effects. Nearly half of these (17) were from one zoo and referred to gastric problems after eating ripening seed cases of oak, chestnut and beech. These are all known to be high in tannin which may be the cause of the recorded problems. Tannins are also likely to be responsible for three reported cases of changes in urine colour. Only four serious (fatal or near fatal) adverse effects were reported.

Discussion

The database is available on CD-ROM from the Federation of Zoological Gardens of Britain and Ireland. Also on this CD is a web-linked interactive list of all toxic plant information of which the authors are aware.

The database shows that most zoos could readily increase their browse supply by using a wider variety of plant species; 113 plant types are listed in the database but the maximum used by any one zoo is 42 and the average only 18. Fear of toxic effects can prevent the use of many plant species which might be readily available. In many cases this fear is well-founded, but often it is based on assumptions and myth. The adverse effects section of this database clearly demonstrates the difficulty zoos have in obtaining reliable information about plant suitability for different animals. For instance, willow is by far the most commonly recorded browse type, with 205 separate records with no adverse effects. However, one zoo stated they did not use it at all due to the aspirin content of the bark. Another example is oak which is commonly thought to be toxic due to its higher tannin content than many other temperate trees. However, it can be seen that many zoos use it with no apparent adverse effects. Some gastric problems have been noted in particular species but these appear to be related to the presence of acorns which are especially high in secondary compounds.

Hopefully, this database and the accompanying toxic plant lists will help to overcome this problem. It will enable zoos to be in a better position to decide whether it is safe to use a novel browse species and thereby increase browse provision for their animals. However, the occurrence of a particular plant + mammal record in the database without an adverse effect does not guarantee that it is safe and zoos must still use their own judgement.

Global Browse database

Evolution of a browse database – a global application

by Nancy Irlbeck, Colorado State University, Merle Moore, Denver Zoological Gardens, and Ellen Dierenfeld, Wildlife Conservation Society, USA

Browse – the new 'buzzword' within zoological communities. Browse can include shrubs, trees, woody vines and stems, including various plant parts like berries and flowers. Browse is used for nutrient supplementation, behavioural enrichment and for some animal species it is life. Browse can also mean death to animals if a wrong plant or part is fed. With all of these parameters – good and bad – browse nutritive and management information has been collected on browse species known to 'nurture' and 'protect' animal collections. Browse databases have been compiled within zoological institutions throughout the United States, Europe, and countries world-wide. Information entered into a database usually centres around a 'specific' country or region.

Since plants grow better in some climates than others, it is difficult to use database information universally. Formats that would allow global application in browse utilisation are critical. Landscape and seed industries recommend plantings based on plant hardiness. Plant hardiness is an index based on minimum temperatures and could be applied universally. For example, in the United States, plant hardiness zones range from 2 to 10, while in Europe they range from 5 to 10. A plant hardiness zone of 5 would include minimum temperatures of -20° to -10° F or -29.0° to -23.5°C. Plant hardiness information is readily accessible on the Internet, and this index could be used to 'begin' the process of developing a global browse database.

It needs to be emphasised that there are many other variables involved in plant growth and resulting nutritive value of browse – humidity and rain fall, soil type, altitude and others. Plant hardiness is not the whole answer, but it is a first step in the development of a database that would allow entry of browse information for global application. Long-term goals for the browse database will be to incorporate it into the Global Food Composition Database proposed by the Conservation Breeding Specialist Group (CBSG) Working Group. The browse section of this Global Database will focus on identified variables utilising current information technology. Fields to be incorporated into an Internet-accessible, intuitive-search database of browse samples include (minimally):

Taxonomy; Phenological characteristics; Plant part(s); Growth Characteristics; Geographic Information and Abiotic Information including GPS co-ordinates (with a hyperlink to mapping capability); Source (i.e. natural vs. cultivated); Date of Collection; List(s) of Consumer Species; Nutrient Data; Bibliographical References; and Links to other existent Databases (i.e. Medicinal, Toxicological, Human Food, Water Quality).

Through the creation of linked global databases with multi-users and contributors, we can begin to identify and fill knowledge gaps to allow us to better understand and meet the nutritional needs of animal species under our care.

Photo: Rob Doolaard/IZP

ZOOTRITION™ in the Netherlands: a joint approach

by Joeke Nijboer, Rotterdam Zoo, the Netherlands and
Tjalling Huisman, Van Hall Instituut Leeuwarden, the Netherlands

Computers and nutrition software for zoos

With the introduction of computers into zoo management, nutrition software has been used and refined. In North America, two computer programmes (Allen & Baer and Animal Nutritionist) were developed in the eighties focussing on zoo animal nutrition. Both worked well for zoos, although the Allen & Baer programme was not used by as many facilities; most zoos, especially in North America, used Animal Nutritionist. The most recent and ultimately final update of the programme in particular contained a lot of information on the nutrient composition of special products used in zoos. However, Animal Nutritionist is not supported anymore. Several zoos use commercial computer programmes which are designed for the livestock feeding industry, or programmes used for human nutrition. Other zoos have customised spreadsheet programmes to calculate their diets. All of the above are very useful, but a single computer programme used in all facilities would be the best option, as experience shows that one programme used by all zoos improves the exchange of data and the spread of knowledge. Programmes successfully used by the zoo community are ARKS for registration purposes, MedArks used for veterinarians and Sparks for studbook registration. Zootrition is diet management software with the potential to be adopted as the standard programme used by all zoos.

ZOOTRITION™: the complete zoo nutrition programme

The first version of the programme Zootrition came out in February 1999, and is supported by the Wildlife Conservation Society, New York with an updated version available in the autumn 2001. Zootrition provides a critical tool to evaluate nutritional quality and standardise dietary records in zoo feeding operations. It contains information not commonly available in human and livestock nutrition databases, for example the composition of whole vertebrates, invertebrates, leaves etc. It also contains nutrient recom mendations from SSP's and TAG's. The programme has a standard or 'global' database, but local databases can also be included. In the future, exchange of information about local composition of foodstuffs, local diets and locally established requirements will be possible via the Internet – the updated version of Zootrition will also be network compatible.

Zoo nutrition in the Netherlands

In 1988, Animal Nutritionist was introduced to the nutrition department of Rotterdam Zoo. The programme was customised to include the results from nutritional analyses performed on local foodstuffs in the Netherlands and these results – from approximately 800 items – were added to the database. In 1993 a project was initiated by the Dutch Federation of Zoos to introduce Animal Nutritionist as an implement for diet formulation in all Dutch Zoos. During that two year project, a new Dutch foodstuff database was collated and most of the zoo diets in use were included in the database.

Through lack of support by N-Squared Incorporated (the company responsible for Animal Nutritionist) and rapid advances in computer technology since the programme had been written, something more sophisticated was required. In 1999, Zootrition was adopted as the common zoo nutrition programme in the Netherlands. An important factor in this decision was the feedback mechanism that would allow updates of the database and other features of the programme according to input from its actual users, and the promise that this would be a regular occurrence. Other important issues were the availability of the newest foodstuff analyses and requirements for zoo animals. Additionally, the potential for connection with ARKS, and receiving updated information via the Internet, played a significant role in choosing Zootrition as the main nutrition program in the Dutch zoos. Therefore, in 1999 initiatives were taken by the nutrition department of Rotterdam zoo, in co-operation with Amsterdam Zoo and Emmen Zoo, to adopt the software as part of the Dutch zoo animal nutrition project.

Project activities

A zoo nutrition project group was set up with nutrition specialists from most Dutch zoos. The original Zootrition program consists out of 3 different global databases: a foodstuff database, a requirement database and a diet database. Every region or country has its own specific foodstuffs, e.g. locally produced pellets. Because the global database does not include the local foodstuffs it was decided to focus on the foodstuff database first. The Animal Management department of the Van Hall Instituut in Leeuwarden was willingly to involve students on a regular basis as part of

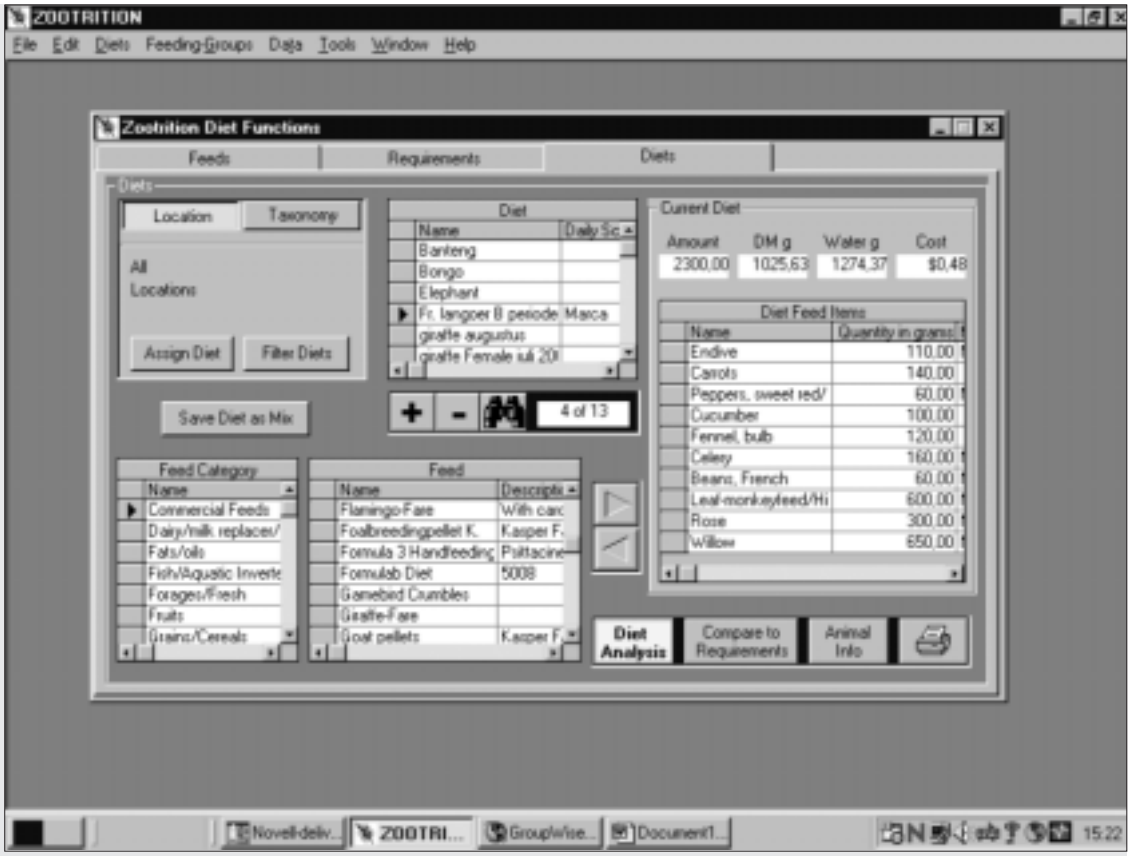

Figure 1
The diets tab. From the screen the user can create a diet by typing in the name of a feed item and selecting the exact feed type from a list.

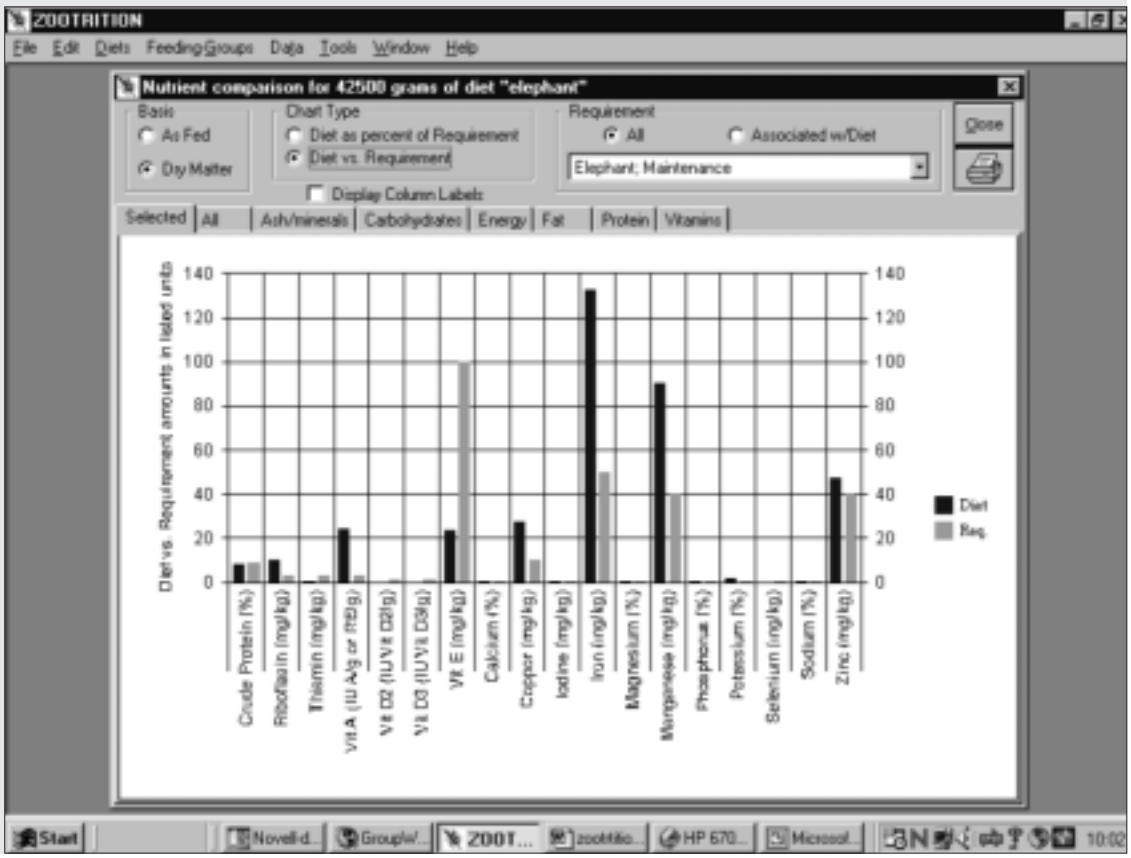

Figure 2
Once created, diets can be compared with the most appropriate requirement model and graphically expressed as a percentage value for easy review.

the nutrition project. They were mainly used to check and compare information in the Zootrition database with the databases from the Animal Nutritionist, for product information from commercial companies and other foodstuffs used in Dutch zoos, like in-house mixes. This proved to be an exhaustive, taking two students more than six months to complete. To separate the Dutch values from the Zootrition values in the source categories of the foodstuff database, the initials for the Netherlands, NL, were added, and in the description category the Dutch name of the foodstuff was added. All the information included in the foodstuff database was printed out and stored in the 'foodstuff database map'.

Nutrition requirements are established guidelines based on extensive scientific research and are proposed by well known institutes. Few of these guidelines exist for zoo animal nutrition. Only the nutrition guidelines in the nutrition sections of SSP's, EEP's, TAG's and Fact Sheets are regarded as established and recognised requirements or recommendations. Most of the recommendations are based on a consensus of good experience but unfortunately relatively little research data. The global Zootrition requirement database contains guidelines from the SSP and TAG's in addition to all the published NRC nutrient requirements. All guidelines were established in the United States. During last year (2000), three students reviewed the zoo nutrition literature in order to find reliable information on nutrient requirements which could be added to the local requirement database. More than 40 relevant volumes of journals were checked for relevant information, over 40 reference books and 30 different conference proceedings and all their available volumes were screened. At least 80 'requirements' were added to the local requirement database. In addition, a large quantity of anecdotal literature was gathered. Some contained useful information for developing diets, but was often suitably reliable to be used for developing requirement standards. An abstract was made from important articles and added to the 'local Zootrition requirement map'.

In 2001, the last part of the project was initiated, to include all diets fed in the Dutch zoos into the central diet database. Many diets were already included in the diet database of the Animal Nutritionist, and if still reliable and up-to-date, they will be included in the Zootrition diet database. Where necessary, students will be sent to all of the participating zoos to measure the actual intake of the diets. It is a huge project, and in order to have reliable data it is essential to develop a system which ensures that the diet data is reviewed at least every two years.

Implementation

The importance of a systematic approach towards zoo animal nutrition is acknowledged more and more in the zoo community. Setting up regionally linked local databases on foodstuffs, requirements and diet data can help to improve the exchange of zoo nutrition information. Using a standard nutrition program like Zootrition is essential for information exchange. Initiatives have been taken to set up local databases in North and South America, Asia and in several parts in Europe. If all the available local databases were placed on the Zootrition website, an overview could be obtained of what is being fed to a particular species almost anywhere in the world!

Setting up local 'requirements databases' and placing them on the Zootrition website can help to establish 'official' guidelines for the global requirement database. To reduce language problems all information is written in English. The updated version of Zootrition will also contain a section in which the native language can be used, in order to produce reports suitable for every member of zoo staff. The first CD-ROM made on the gathered information will be updated and distributed among the Dutch zoos in 2001.

To establish a project like the Dutch Zootrition Foodstuff, Requirement and Diet database is very time consuming, because few people employed by zoos have enough time or financial support to spend several years setting it up. The assistance provided by motivated and enthusiastic students in our project, particularly those with experience or interest in zoo nutrition, proved indispensable. Critically evaluating nutrition literature for zoo animals is difficult. Ideally it should be done by experienced nutrition researchers but this is not always possible. Furthermore a project such as this will fail its purpose if it is not regularly updated. Therefore we intend to devise a system that will ensure regular revision of the three local databases.

Conclusion

The zoo nutrition computer programme Zootrition is a critical tool to evaluate diets. The programme will be updated regularly and adjusted to the specific wishes of their users. If used by many zoos, with all the data available, it will help in the exchange of nutrition information, to improve zoo nutrition and ultimately to establish better nutrition guidelines for zoo animals.

First announcement

joint nutrition symposium

Antwerp, Belgium > August 21-25, 2002

Joining societies

Comparative Nutrition Society
CNS 4th symposium

European Society of Veterinary and Comparative Nutrition
ESVCN 6th symposium

European Zoo Nutrition Research Groug
EZNRG 3rd symposium

The symposium has been set up as a unique opportunity of meeting nutrition researchers from very different viewpoints. The congress will be split in three parts, one for each joining society. The organisers wish to encourage members of one society to participate in sessions of the other societies. The symposium – including joint sessions – will allow an innovating discussion of several strategies in comparative nutrition and will enhance the linkage between practice and fundamental aspects. Social and scientific contacts are as pleasant as they are in the marvellous setting of historical buildings surrounded by zoo animals and the lively city of Antwerp.

Time schedule of the symposium

	Morning sessions	*Afternoon sessions*
TUESDAY August 20		arrival
WEDNESDAY August 21	ESVCN	ESVCN
THURSDAY August 22	Joint session ESVCN & EZNRG	EZNRG
FRIDAY August 23	EZNRG	Zoo Visit
SATURDAY August 24	Joint session EZNRG + CNS	CNS
SUNDAY August 25	CNS	departure

Symposium venue
(www.flanderscongresszoo.com)
The symposium venue is the Flanders Congress and Concert Centre, located at the Antwerp Zoo. The congress centre hosts contemporary congress facilities in a unique historical building with nine different halls and meeting rooms.
The 19th century buildings of the Royal Zoological Society witness to the transition from neoclassicism to eclecticism. In 1997 the museum room on the first floor was officially inaugurated as the Darwin Hall, a conference room where the majestic skeleton of a whale is exhibited. Social and professional contacts will surely be stimulated in the setting of this symposium venue. Moreover, the symposium registration fee also covers free entrance to the Antwerp Zoo during the days of participation of the symposium.

Antwerp City
Antwerp has a medieval city centre at the borders of the Schelde river but has expanded considerably. The city offers a high concentration of all kinds of cultural events and a sparkling night life for those interested. It is the city of painters as Rubens and Brueghel, the music from baron Toots Thielemans, Deus and I Fiaminghi.
A social programme is under construction.

Hotel booking
Accommodation of all budget categories are in the neighbourhood of the Congress Centre. Specific information will be available soon.

Travel
The Antwerp Congress Centre is next to the railway station of Antwerp Central and can be reached by rail from Brussels Airport in Zaventem (www.brusselsairport.be) in about an hour. From specific places flights can be booked directly to the Antwerp Airport in Deurne (www.antwerpairport.be).
The connection to the congress site is easy by bus or taxi.

Executive committee
Geert Janssens – Joeke Nijboer – Kristin Leus – Jean-Michel Hatt – Robert White – Marianne Diez

If you would like to be informed on this symposium, send a message to:
Geert Janssens
Laboratory of Animal Nutrition - Ghent University
Heidestraat 19, B-9820 Merelbeke
Tel. +32 9 2647828 / Fax +32 9 2647848
nutrition@rug.ac.be
http:
//allserv.rug.ac.be/~gjans/symposium.html

2nd European Zoo Nutrition Meeting

Conference programme

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Advancing zoo nutrition through global synergy
Ellen S. Dierenfeld

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Copper deficiency in yak (*Bos grunniens*) at Whipsnade Wild Animal Park
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2nd European Zoo Nutrition Meeting

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Diet data collection

Practical problems with data collection for nutritional analysis: a study of animal diets at Bristol Zoo Gardens

by Angela Bond, Bristol Zoo Gardens, United Kingdom

With the wild diet often unavailable or unknown, most zoo diets have evolved over time through trial and error, and since very little is known about the nutritional requirements of exotic animals, many of these diets have very little scientific basis. If we are to improve the nutrition of our captive animals it is important that we identify, record and assess these diets in a more scientific manner.

In August 2000 I began to collect data on the nutritional contents of the diets consumed by 30 species of birds, mammals and reptiles at Bristol Zoo Gardens, all of which have now been entered into the diet management software package, Zootrition. (ZOOTRITION™ 1999, Wildlife Conservation Society). Zootrition is a software package that can analyse diets if their constituents are known. If software such as Zootrition is to be of value to the Zoo community the data entered into it must be accurate. This article outlines some of the many areas where inaccuracies occur, and suggests ways in which these problems can be reduced.

Photo: Rob Doolaard/IZP

Data Collection

Data collection procedures varied depending on the species being studied. The mammal species were the easiest to study because they tended to eat the majority of the food items that were offered to them. In contrast, data collection for the bird species was much more time consuming. This is because the birds did not eat all of the food items that they were offered. Furthermore, their diet consists of small food items such as pulse, grains and seeds, making the separation and identification of left over food more difficult. Of the reptiles, the herbivorous species were more problematic since their diets included weeds and grasses for which nutritional information is scarce. In contrast, data collection was simple for the carnivorous reptiles (including snakes) since diet records are kept on section for each animal. These records are especially useful because of the low frequency with which these species are fed.

What is being fed to the animals?

The first thing to establish when studying an animal's diet is the identity and quantity of the food items that are being fed to the animals. It is not enough to simply observe the diet sheets on section, for a number of reasons.

- Food items on diet sheets are not usually listed as weights but as arbitrary amounts. For example 'two carrots' yet the weight of one carrot was found to range from 54g to 180g, leading to large variations in the quantity fed.
- Different keepers interpret diet sheets in different ways. Some keepers are more generous with feed portions, some are keener to experiment with unusual feeds and others are more vigilant over the quality of food items.
- Foods involved in enrichment exercises are often not included in the diet sheets and form a rather random part of the diet. Variation of this kind could be especially significant since enrichment foods tended to be high protein foods such as cheese, nuts and live food.
- There is a great degree of seasonal variation in the diet either by choice, whereby the keeper deliberately alters the diet at different times of the year such as during the breeding season, or as a result of the seasonal availability of foods.

All of the above factors contribute to the massive variability in the diet offered to an animal. In an attempt to accommodate this variability, each study was carried out for about a week and an average intake of food per day was ascertained.

Diet data collection

What is being eaten by the animals?
Animals fed a mixed diet in excess are able to satisfy their hunger by selecting only their 'favourite' food items. Since it is generally accepted that birds should never be left without food due to their high metabolic rate, they tend to be fed a lot of excess food. Hence, the most selective feeders of the species studied were all birds; taritic hornbills (*Penelopides panini*), tocotoucans (*Ramphastos toco*) and superb fruit doves (*Ptilinopus superbus*).

When an animal does not eat all of the food offered to it, it is necessary to identify the proportions of each component consumed. However, presenting these components separately affected feeding behaviour. One method that was adopted was to dry out the uneaten food to enable the components to be separated sufficiently.
A more subtle form of selectivity exists, whereby the animal does not consume the entire food item – leaving peel, seed hulls etc. Therefore merely weighing remaining food items may give misleading results. For instance, because the nutritional content of orange peel and orange flesh are different, merely measuring what remains and analysing as 'orange' will not give accurate results.

	Orange with peel	Orange without peel
Iron (mg/kg)	45.20	7.55
Vitamin C (mg/kg)	4011.3	4015.0

Data from Zootrition

Of the animals studied, orange and kiwi fruit peel was often left uneaten by the Geoffroy's marmoset, pygmy slow loris and two-toed sloth. The bird species receiving fruit and seed diets tended to leave seed hulls and some apple peel uneaten.

Competition for feed
When trying to establish what is eaten by an animal it is important to consider competition for feed. Significant quantities of an animal's food can be eaten by local wild pests such as cockroaches, rodents, pigeons and starlings. This may lead to an overestimation of the quantity of food that the animal is eating. It may also lead to inaccurate conclusions regarding food preferences. The impact of these pests can be significant. During a study of the diet of red-vented cockatoos (*Cacatua* spp.), two groups were considered. One group was found to be eating 100 g of feed per bird per day, whilst the others were apparently eating 275 g of feed per bird per day. The second group was housed in an enclosure that was accessible to wild birds which were stealing food from the cockatoo feed dish.

Even where wildlife is excluded, competition for food takes place. In a mixed species enclosure interspecific competition for food will occur. The extent to which such competition affects the food intake of each species is largely unknown and has not been investigated in this study. Within single species enclosures there will be intraspecific competition for food such as the famous 'pecking order' established in groups of domestic hens. Interspecific and intraspecific competition for food will lead to one individual animal receiving a different quantity or quality of food from another individual animal.

Nutritional Content of the diets
Once the field data for a diet had been collected, the nutritional content of the diet was calculated using Zootrition. The nutritional content will only be as accurate and complete as the data that is entered into Zootrition.

Causes of inaccuracies include:
Identification Food items are not widely referred to by their scientific names, which leads to confusion when searching the literature for nutritional analysis data and when using the Zootrition software.

Photo: Rob Doolaard/IZP

Diet data collection

Nutritional Analysis Once identified, obtaining detailed and accurate nutritional information on the food products can be challenging. Of those contacted, 75% of the suppliers of commercial mixes could not, or perhaps would not, provide a detailed nutritional analysis. Furthermore, excepting the data already entered into Zootrition, there is a dearth of information on food items not commonly used for human consumption. For example, chickweed, the leaves of brussel sprouts and raw meat/fish/vegetables.

Substitution The limited availability of nutritional information means that it is necessary to substitute a food item for which the nutritional content is unknown, with the closest related known one. This is a source of further inaccuracies in the nutritional analysis of the total diet.

Limitations of the data collected

Sample size As is the case with many studies of exotic species, data collection was restricted to small sample sizes and the results obtained should be treated accordingly.

Individual food preference Individual food preferences have been found to be quite strong in some cases, particularly in kea where preferences for egg, cheese and peanuts differed greatly between individuals.

Time scale The short time scale of the study means that any seasonal or age-related changes in diet and eating behaviour will not have been included in the results.

Data for comparison Ideally, once the nutritional content of the diets has been established, this can be compared to the nutrient requirements of that species. Unfortunately the nutrient requirements of the majority of exotic species have not been determined. Comparisons to similar domestic species are not satisfactory.
It is therefore not possible to be too prescriptive when looking at the nutritional analysis of these diets.

Conclusion

If diet studies are to be of any real value to nutritionists the data collection procedures must be accurate. They must take into account the variability of zoo diets, considering both daily and seasonal variation and the inclusion of enrichment foods. It is vital that research focuses on the diet actually eaten by the animal, not simply what is offered to the animal since selection by the animal and inter/intra specific competition for the food will alter the composition of diet.

Finally, there is a real need for the pooling of nutritional data, made possible through contributions to the Global Zootrition Data base and through the work of the European Nutrition Group. This will help to distinguish individual preferences from species preferences and the analysis of proven successful diets (and equally, proven unsuccessful diets) will provide data against which other diets can be compared.

Further food for thought

During the course of my study into zoo diets, it became very apparent that food was used as the main source of enrichment for almost all of the species studied. A keeper's perception of a good diet is invariably one that involves fresh food. Nuts that need cracking, fruit that needs peeling and live food that needs to be caught all increase the food handling time and thus the activity of the animal.

However, as has already been discussed, fresh food diets can be extremely varied in their composition, and consequently their nutritional content is not reliable. Therefore, if the nutritional requirements of an animal have been determined, the only way to be sure that the correct nutrients are always available to the animal is by feeding a commercial diet. At present this means feeding pellets. Pellets have the added advantage that they are very easily modified; individual nutrients can be increased or decreased at the manufacturer's will. However, compared to a fresh fruit diet, pelleted diets are perceived as boring and non-stimulating for the animal. This is because;

– Fresh food is closer in appearance to what would be received by the animals in the wild.
– Fresh food diets are more appetising to us (humans).
– Fresh food diets are an 'easy' source of enrichment.

This association between diet and enrichment inevitably results in one being compromised for the other and at present it is the nutritional quality of feeds that seems to be suffering. Surely the answer is to uncouple these two very separate issues. The nutritional intake of the animal must be determined by the diet whereas enrichment can be provided in other forms.

Perhaps if in the future more emphasis is put on food presentation rather than food variety, it will be possible to consistently feed a nutritionally balanced diet in a way that still provides enrichment for the animal.

Animals' nutritional wisdom

Pros and cons of cafeteria-style feeding

by Helena Marqués, Gemma Navidad, Barcelona Zoo,
and Mariola Baucells, Elena Albanell, University of Barcelona, Spain

Most of the factors that determine the foraging ecology and food selection of animals in the wild still remain unknown. It is not clear whether the animals have nutritional wisdom or not. Some authors support the idea that it is the environment that balances the diet of wild animals. The great variability of foods and the seasonal changes condition the composition of the daily diet of the animals (Donoghue and Stahl, 1997). According to Robbins (1993), food habits, foraging patterns, energy and time expenditures, and individual wellbeing depend on the animal's perception of its energy and nutrient requirements relative to the spatial and temporal distribution of its nutritional environment.

In general, it is considered that animals basically consume only to meet their daily needs of water, energy and to a lesser extent, salt. However, it is not clear whether they are able to consume the appropriate levels of each of the other nutrients. When feeding captive wildlife, the most widely used method is Cafeteria Style Feeding (CSF): offer a wide variety of food – usually fresh – to let the animals make their own diet (Allen, 1982). The total amount of food can be ad libitum which will give the animal a great chance of choice feeding, or more adjusted to the intake capacity of the animal that will allow just certain degree of choice feeding to almost none. At the other end of the scale there is Complete Feed Style Feeding, which consists on a homogeneous diet formulated to meet the estimated nutrient requirements of that specific species. In this case, choice feeding is impossible. In general, in captive wildlife feeding practice, the complete feed is one of the ingredients offered in a CSF, and seldom offered as the unique diet choice.

Cafeteria style

There are several studies on animal production that demonstrate and support the idea of 'choice feeding'. It has been observed that pigs and broiler chickens given a choice between two foods with different protein concentration have the ability to eat amounts of the two that give a diet that is close to optimum for growth. There is also evidence that growing chicks and broilers can differentiate from foods with different lysine and methionine concentrations respectively (Forbes and Shariatmadari, 1994). Another example is the strong appetite of laying hens for calcium, which seems to be the determining factor in their food selection. However, it is also accepted that a learning period or adjustment is needed before becoming proficient when given a choice of foods (Forbes and Covasa, 1995).

In wild animals there are also several papers that show a certain degree of nutritional wisdom for a few nutrients. For example, multiparous and reproductive females of common marmosets have a preference for calcium solutions (Power et al. 1999). McNaughton (1990) presented some evidence that the seasonal movement of migratory grazers in the Serengeti ecosystems are related to grass mineral content. There are many studies on primates that also reflect the preference for young plant parts, less fibrous and higher in protein content, which are more digestible and may be better utilised by an animal lacking a specialised gastrointestinal tract (Milton, 1978).

In some cases, there isn't any other better way of feeding a group of animals in captivity, than CSF. For instance, in big groups of animals (of the same or different species), where there may be a strong monopoly of the food source by certain dominant individuals and/or where the nutrient requirements for each species may be completely different and a unique diet is not possible. These cases always require close monitoring.

Discussion

According to all these examples, one might get the idea that CSF is a good feeding method. However, if animals had the ability to balance their diet according to their needs we wouldn't find animals in captivity with nutritional insults, and unfortunately, nutritionists have seen countless cases where the choices made by zoo animals result in nutritionally unbalanced diets (Oftedal and Allen, 1996). Moreover, we find animals that suffer dehydration or obesity, despite the fact that we know animals can regulate their energy and water intake. Dehydration occurs, for example, because water regulation capacity develops with age (as in piglets), or because there are animals that will never be able to completely regulate their water balance (like cats); obesity results when animals fail to regulate their energy intake due to the palatability of the diet or because the diet is not balanced.

In captivity animals don't find the complexity and seasonality of food resources in the wild, and additionally, it has been

Pheasant pigeon

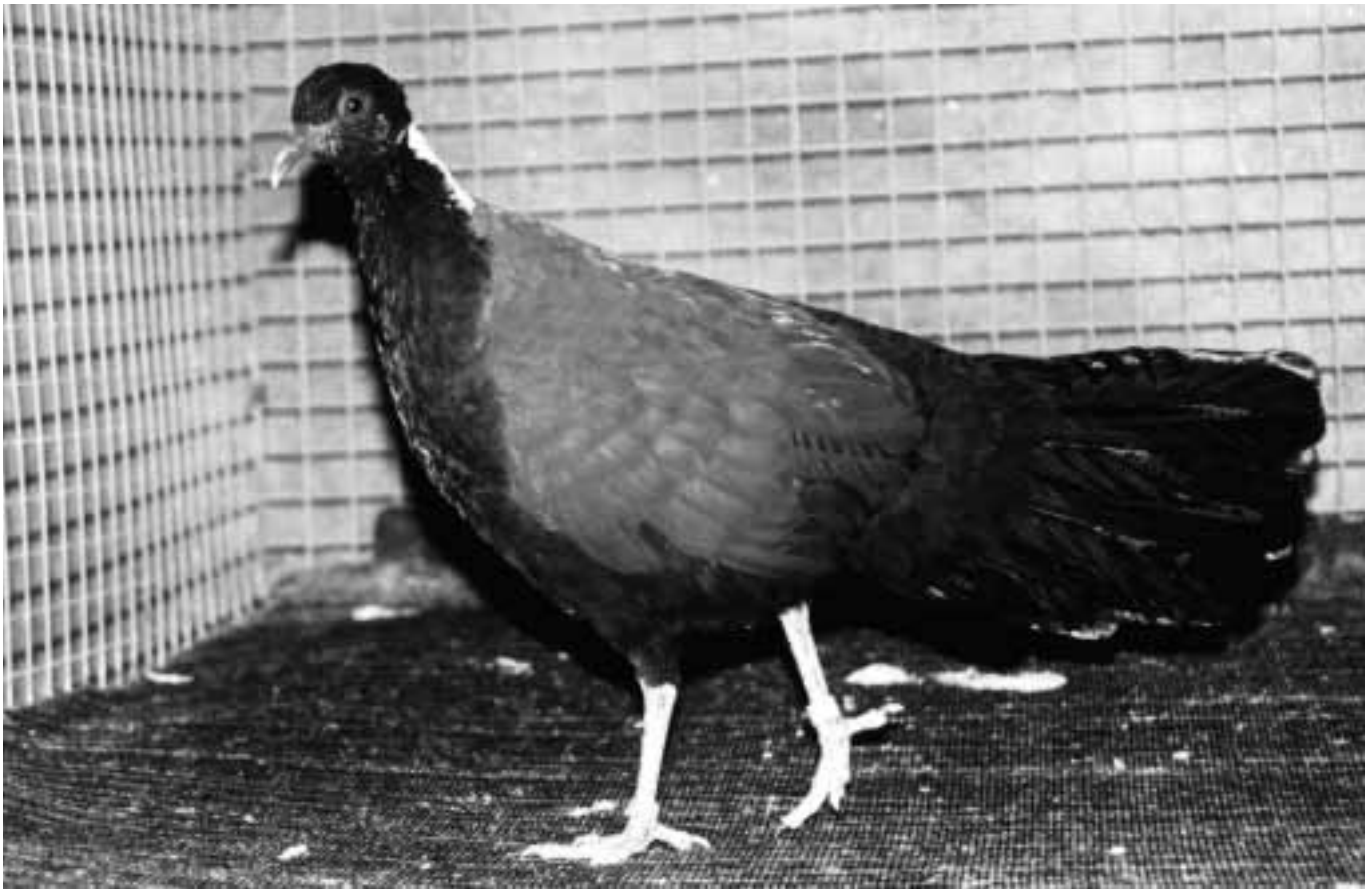

Photo: Helena Marqués

frequently demonstrated that items of importance in human or livestock nutrition are only superficially similar to foods available in the wild. Thus, in captivity animals are faced with choices that they have not evolved to make (Oftedal and Allen, 1996).

Additionally, there are many other factors known to influence food selection, which are not strictly related to the nutrient content of the diet but are also relevant, like the physiology and morphology of the intestinal tract, and the taste, texture, size and colour of the ingredients.

Example: Study on the diet of the white-naped pheasant pigeon in captivity

A study was performed at the Barcelona Zoo to investigate the diet of 11 (8.3) white-naped pheasant pigeons (*Otidiphaps nobilis aruensis*). The diet offered (DO) consisted on 10 different ingredients: 1-wheat, 2-millet, 3-canary seed, 4-Universal insectivorous diet, 5-frugivore supplement, 6-egg-rearing food with hedgerow plants, 7-lettuce, 8-fruit mix, 9-hard boiled egg and 10-mealworms *Zophoba* sp. (Marqués et al, 2000). All of them were offered close to ad libitum (CSF), except for one (*Zophoba* sp.) that was used to encourage animals to go on a weighing scale every day.

Each animal consumed only 23% of the DO, per day. Food preferences were extremely different among individuals, but some ingredients were mostly refused (4 and 6), and others widely preferred (10).

Due to the great variability of food preferences among individuals, and in order to draw some 'population' conclusions, diet ingredients were grouped into 4 categories: grains (1-3), commercial feeds (4-6), fresh vegetables (7-8) and animal protein (9-10).

When looking at the mean diet consumed (DC) of all pigeons on a dry matter basis, grains represented more than 50% of the diet. The supplement for frugivores was consumed in a second place (29%) and third was live prey (6%). The rest of the ingredients were barely consumed. Faunivores in captivity have a propensity for overeating, as they are used to performing hunting behaviours assiduously (Dilger, 1982). This could have happened if *Zophoba* sp. had not been limited.

Animals' nutritional wisdom

According to age, pigeons under 10 months consumed significantly less grain than pigeons over that age, whereas younger pigeons had a tendency to consume more commercial feeds. It has been suggested that the digestive tract of animals with a completely different diet during their early developmental stages (pigeons feed their young with crop milk), tends to adapt as diet habits change. So, the capacity to digest carbohydrates may develop later (Kirk Baer, 1999).

Pigeons were also separated into two separate groups of siblings. There were differences in the consumption of wheat and canary seed between them. This suggested a different pattern of food selection by the parents, which could have influenced the youngsters through the imprinting period.

However, when looking at the nutrients, neither DO nor DC adjusted to the nutrient requirements for pigeons (Vogel et al, 1994). Protein was within the recommended range, although this is quite large, fat was over the requirements and fibre didn't meet the recommendations. The estimated daily Metabolizable Energy intake represented 1.7 x Basal Metabolic Rate (BMR), which was within the range generally accepted for maintenance (1.5 - 2 x BMR).

Conclusion

In general, most wildlife nutritionists agree that there is no evidence to support the idea that captive animals choose their food in relation to its nutritional properties. Additionally, the factors that stimulate an animal to select its diet in the wild are different in captivity. Therefore, CSF it is not widely accepted by zoo nutritionists, and it is the job of the nutritionist to make the choices for the animal under his/her care.

In order to make the right choices, it is necessary to monitor on a regular basis all the aspects related to the feeding and nutrition of the animals (i.e. food preferences, intake, feeding behaviour, body condition, nutritional status, etc.).

To support the decisions taken by the nutritionists, it is essential we learn more about the true requirements of the animals in captivity and in the wild, and the real composition of the natural diet. We shouldn't forget that the feeding behaviour and food selection patterns of both captive and wild animals might provide us with valuable information to improve the diets of animals under our care.

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Visitors' nutritional wisdom

Visitors' views on browse use in captive gorilla and giraffe diets

by Tjalling Huisman and Conchita Mascini, Van Hall Institute, The Netherlands[2]

Browse, (leaves and branches of trees and shrubs), is a frequently used product in zoo diets. However it is hardly used outside this particular field of nutrition and therefore relatively little is known about its nutritional value and proper use.

As part of a more comprehensive study which aims to investigate in more detail the nutritional value of browse in zoo diets, interviews were conducted with staff responsible for zoo nutrition in 10 Dutch zoos. Almost all respondents indicated that they experienced the following problems with browse: irregular availability, lack of reliable nutritional data and storage problems. Respondents also indicated that they would like to explore the possibilities for replacing browse in the present rations. (Kool and Smit, 2000)

The obvious approach towards replacing food items in a diet is to look for products with comparable nutritional properties and suitability as environmental enrichment. However in a zoo setting it is possible that there are also other factors which play a role. One of these factors is the public's attitude towards the feeding of the animals and the food items used. A follow up study was conducted in co-operation with Rotterdam Zoo and the Department of Nutrition from Utrecht University in order to examine this novel aspect of zoo nutrition (Mascini, 2001).

Methods

A total of 300 Rotterdam Zoo visitors were interviewed on the subject of gorilla and giraffe feeding over three separate days. Knowledge of facts about the feeding of these animals was explored by asking respondents thirty questions about the necessity of ration components, the animal's feeding behaviour and the specific function of certain diet components. Further questions determined the importance of browse availability in animal enclosures, for zoo visitors.

Visitor's knowledge about nutrition

For obvious reasons members of the zoo were expected to have more knowledge on the subject. However results showed no significant differences in knowledge about gorilla and giraffe feeding between members of the zoo and other visitors. Scientific literature states that domesticated fruits are not necessary diet items for gorillas and may even have adverse effects when fed in large quantities. Yet most visitors did not know this. The majority of respondents (76%), expressed the view that bananas are a necessary item in gorilla diets. When the same question was asked about fruit in general almost all (94%) thought that this was a necessary component in gorilla diets. An even more contentious item in adult gorilla diets is milk. However, almost 40% of the visitors viewed it as a necessary diet component.

Crude fibre sources such as browse, are important in gorilla diets. Slightly more then 60% of the visitors thought gorillas need branches and leaves in their diet, whereas less than a fifth (17%), considered concentrate as a necessary diet component. More than 75% of the respondents stated that branches are necessary for play behaviour and approximately two-thirds (60%) of the respondents thought that browse was important for teeth cleaning.

The results for giraffe nutrition were less striking. Only 37% of the visitors thought that fruits were a necessary diet component for giraffes, while for vegetables this figure was 46%. Over 75% expressed the view that both hay and leaves are an important diet component. Only 35% of the respondents agreed with the statement: "The digestive system of the giraffe is similar to the digestive system of cattle". Overall just 50% of the questions were answered correctly.

Availability of browse in animal exhibits

More than 65% of the visitors agreed with the statements that an animal exhibit without browse looks neater, more hygienic and offers a better view. However this does not mean they believed that browse should be replaced. Almost two-thirds of the visitors (60%) stated that the animal enclosures would be less attractive if no browse was fed. A third (34%) indicated that this would seriously affect their pleasure in visiting the zoo, (Figures 1 and 2).

Conclusions

Although this study was conducted on a small scale, the results demonstrate that it would be worthwhile to direct some effort towards educating the public about the choices made when formulating zoo diets. Visitors enjoy a zoo visit

2 *Additional Project Participants*
J. Nijboer, Rotterdam Zoo. W.L. Jansen, Utrecht University and B. van Wijk, Van Hall Institute, The Netherlands

Visitors' nutritional wisdom

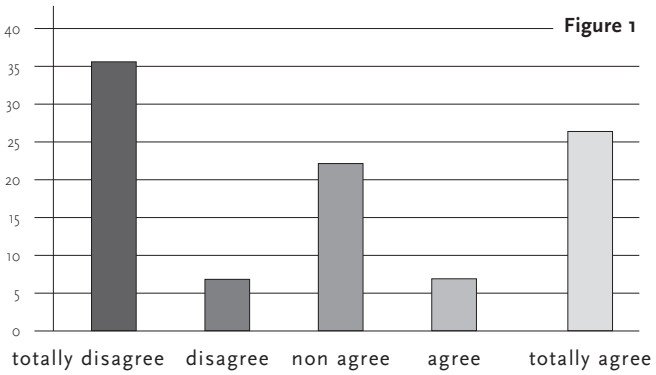

Figure 1 Answers given concernig question:
'I think enclosures including branches and leaves look more natural'

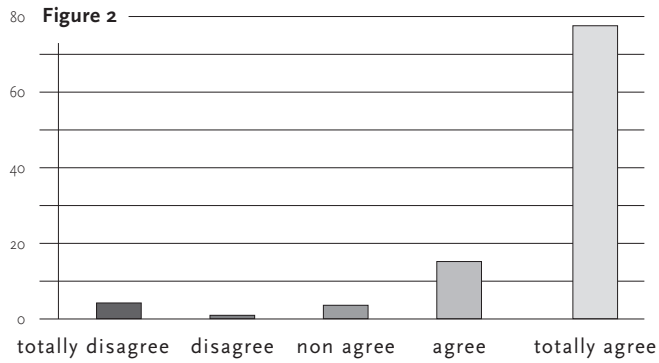

Figure 2 Answers given concernig question: *'If they stop feeding gorilla and giraffes branches and leaves, I will like it less visiting the zoo'*

not just because of the animals, but also because of the environment the animals are exhibited in. This study indicates that, in the visitors' perception, diet offered is an important component of this environment.

Furthermore, an important objective of zoos is the education of the general public on aspects of animal biology and conservation. Indirectly, the nutrition of animals, especially what visitors can observe, is an educational tool. One can hardly expect an increase in visitors' knowledge of zoo animal nutrition, if the items offered are not comparable to what the animals eat in the wild. The diet actually on offer within the exhibit could make more of an impression than the information provided by interpretation panels.

Finally, this study shows once more, that in zoo animal nutrition it is not only the 'nutritional' aspect which is important. Zoo animal nutrition policy requires a multidisciplinary approach, which makes it even more complicated than we have already acknowledged.

Photo: Rob Doolaard/IZP

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Abstracts & Proceedings

Second European Zoo Nutrition Meeting

The Second European Zoo Nutrition conference was scheduled for April 2001, Southampton, United Kingdom in co-operation with Sparsholt College, Hampshire and the University of Southampton.
The conference was supported by European Association of Zoos and Aquaria Research Group and attracted almost 60 oral and poster submissions. It was with great regret that the organisers cancelled the meeting due to the outbreak of Foot and Mouth disease in the UK. However, all the participants who had submitted abstracts for oral or poster presentation have given their permission for publication of their material in one form or another.
The abstracts have been compiled and a volume of proceeding is planned – details of how to obtain both are provided below.

Abstracts

The abstract book contains short summaries of all the topics mentioned in the Conference programme (p18-19).
Copies of the conference abstract book can be purchased from Marwell Preservation Trust.
Address your requests to purchase copies of the abstract book to:
Nutrition Conference Abstract Book, Marwell Zoological Park, Owslebury, Winchester, Hampshire, SO21 1JH, United Kingdom.
Fax: +44 (0) 1962 777511.

Proceedings

A second volume of Zoo Animal Nutrition (ed. A.L. Fidgett, J. Nijboer, *et al*.), based on selected contributions submitted for the Second European Zoo Nutrition Conference, will be available summer 2002.

The first volume of Zoo Animal Nutrition (Ed. J. Nijboer, J.M. Hatt *et al*) is still available. Based on contributions to the First European Zoo Nutrition Conference it covers major subjects needed to properly feed zoo animals. Subjects range from functional morphology of digestive systems to behavioural ecology of feeding; from behavioural implications of food presentation to mineral status, and from lactation and egg production to pathological aspects. Amongst the taxa included were fish, snakes, tortoises, several groups of birds, macropod marsupials, chiroptera, primates and ungulates.

The book draws upon the expertise of veterinarians, nutritionists, behavioural biologists, ecologists and zoo managers to provide an interdisciplinary overview of the field of zoo and wild animal nutrition. Thus it is of importance not only for captive propagation and zoo biology but also for a better understanding of the food-related dimensions of niche dynamics.

Those wishing to purchase the conference proceedings can use the order form below.

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The European Zoo Food Suppliers Association

The supply of **high quality food** has become a major topic since the recent food crises in Europe. Local and European rules and regulations on zoo foods are currently being reviewed. The new legislation does not only affect us as suppliers, but are also extremely important to our customers : European Zoos, Bird Parks, Aquariums and Falconers. For this reason we decided to unite our interests into one organisation, **The European Zoo Food Suppliers Association (EZFSA).**

Together we aim to set up programmes on the following topics :

- **promotion and improvement of R&D on food products,**
- **quality assurance for the production and supply of zoo food,**
- **combination of logistic resources to reduce transportation costs,**
- **risk reduction,**
- **improving our position towards European Commissions,**
- **extension of economic benefits on a European scale to customers,**
- **how to operate in Europe with open veterinarian borders.**

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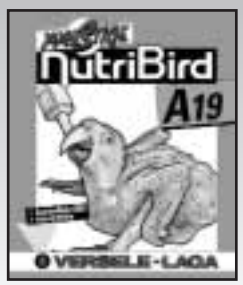

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Closing Remarks

Future of European Zoo Nutrition

European Zoo Nutrition Research Group (EZNRG)

Although the Second European Zoo Nutrition Conference was cancelled, a smaller group of people met at Marwell and discussed the future for zoo nutrition in Europe. It was decided that forming a research group would be a positive, and indeed necessary step for the advancement of a meaningful research programme in zoo nutrition. While it does not need to be an official Society, the group would benefit by being a part of the EAZA research group.

The formation of a European Zoo Nutrition Research Group (EZNRG) has been initiated by Peter Bircher (Marwell Zoo), Jean-Michel Hatt (University of Zurich), Alastair Macdonald (University of Edinburgh/Vice Chair of the EAZA Research Group) and Joeke Nijboer (Rotterdam Zoo).

The group will be objective-orientated, so rather than attempting to address all issues at once, it would identify specific problems, determine the end point or goal, find the money and personnel to achieve it, then make the results available to the wider zoo community. Targets have already been identified and we now need people willing to organize and undertake that work. If you would like to be involved or just find out more see below for contact details. Progress of the first projects initiated could be presented at the 3rd Zoo Nutrition Conference which will be held from 21-25th August 2002 in Antwerp (see announcement earlier in this newsletter).

Some targets already suggested:
- Supporting EEP and TAG programmes in preparing their nutrition sections
- Setting up Browse Databases
- Establish a Physiological Database
- Establishing an Institute for European Zoo Nutrition.
- Subgroups to investigate nutritional requirements of:
  Ungulates, particularly Giraffe / Elephant / Rhino
  Primates / Pigs
  Herbivorous Reptiles / Parrots

Furthermore, to sustain European zoo nutrition research and improve the exchange of nutrition information the EZNRG plans to advise EAZA to adopt ZOOTRITION™ as the standard zoo diet management software. EZNRG will support this endorsement by providing:
Basic/advanced training on how to use ZOOTRITION™
Advice on implementing ZOOTRITION™ to manage diets within a zoo
Maintenance of a European Database of Feeds

European Zoo Nutrition Research Centre

To co-ordinate, stimulate and generally improve zoo nutrition, Walter Jansen and Joeke Nijboer are currently planning to establish an Institute for European Zoo Nutrition Research Centre (EZNRC) in the Netherlands. The objectives of the Institute will be:
- Coordinate zoo nutrition research projects throughout Europe
- Initiate zoo nutrition projects
- Set up a zoo nutrition literature database
- Formulate diets
- Establish feeding programmes in zoos
- Zoo nutrition education
- Product development
- Feed purchase optimisation

To become involved or just find out more about the European Zoo Nutrition Research Group contact:
Joeke Nijboer, Rotterdam Zoo, Van Aerssenlaan 49, 3039 KE Rotterdam, The Netherlands
Email: j.nijboer@rotterdamzoo.nl
Fax: +31-10-443 14 14

A scientific board of specialists drawn from universities, zoos and zoo-related organisations will be established, to co-ordinate the goals of the Centre. We hope to have at least two full-time staff members working at the Centre and will actively encourage opportunities for students to conduct projects based at the Centre. Finance for the Centre is being applied for from industrial, environmental and governmental sources. However members of EAZA will be asked to support the Centre, since much of the research output generated will be to their advantage:

- Support from zoo nutritionists
- Zoo diets based on scientific knowledge of nutrition
- Improved enrichment
- Fewer feed-related health problems
- Improved longevity
- Improved breeding results
- Lower feed costs
- Improved hygiene
- Lower labour costs

Financing the EZNRC will be only a small part of what can be achieved. It is estimated that annually, if the food bills in all EAZA zoos were only reduced by 10%, the reduction in costs could be up to 4-5 million Euro! If more of the benefits listed above, e.g. improved hygiene, less feed related problems and labour costs, improved longevity and breeding results, were achieved the savings, for all EAZA zoos, could be at least 15 million Euro a year.

A Centre which works for all the EAZA zoos will be a unique example of how European zoos work together to achieve a specific target of improving zoo nutrition. This is not an unrealistic goal, but one that can only be achieved if adequate communication between all the different participants is established and thus it will rely heavily on modern methods of communication, i.e. e-mail and the internet, in addition to the more established conferences and workshops already underway. This is surely the way forward for zoo nutrition in the 21st century.

Joeke Nijboer, Rotterdam Zoo; Andrea Fidgett, University of Glasgow; Walter Jansen, Jargan Zoological

Who is Who in EAZA

EAZA Executive Committee

Chairman:
Miklós Persányi, Budapest Zoo
Vice-chairman:
John B. Stronge, Belfast Zoo
Secretary:
Ton Dorresteyn, Rotterdam Zoo
Treasurer:
Roland Van Bocxstaele, Antwerp Zoo
Chair EEP Committee:
Leobert de Boer, Apenheul Primate Park
Advisor:
Gunther Nogge, Cologne Zoo

EAZA Executive Director

Koen Brouwer, EAZA Executive Office, Amsterdam

EAZA Committees & Working Group Chairs

EEP Committee:
Leobert de Boer, Apenheul Primate Park
Legislative Committee:
Not yet determined
Veterinary Committee:
Felix Weber, Goldau Zoo
Membership & Ethics Committee:
John B. Stronge, Belfast Zoo
Research Committee:
Gunther Nogge, Cologne Zoo
Aquarium Committee:
Gordon McGregor Reid, Chester Zoo
Conservation Committee:
Jo Gipps, London Zoo
Education & Exhibit Design Committee:
Lars Lunding Andersen, Copenhagen Zoo
Committee on Technical Support & Assistance:
Dominique Tropeano, Colchester Zoo
Committee on PR & Marketing:
Henning Julin, Aalborg Zoo
Bushmeat Working Group:
Bryan Carroll, Bristol Zoo

EAZA Zoo Information Centre (ZIC) Representatives

Baltic States:
Guna Vitola, Riga Zoo
Czech Republic & Slovakia:
Tomás Kapic, Prague Zoo
Hungary:
Tibor Kovács, Budapest Zoo
Poland:
Agata Borucka, Warsaw Zoo
Russia:
Tanya Arzhanova, Moscow Zoo
Ukraine:
Alla Nikitina, Kyiv Zoo

Committee Chairs co-opted in Council

Lars Lunding Andersen, Copenhagen Zoo
Henning Julin, Aalborg Zoo
Gordon McGregor Reid, Chester Zoo

EAZA Council Members 2000 - 2002

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Belgium
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Denmark
Hans Kofoed, Odense Zoo
Estonia
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Finland
Seppo Turunen, Helsinki Zoo
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Françoise Delord, Parc Zoologique de Beauval
Michel Hignette, Aquarium du MAAO, Paris
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Wolfgang W. Gettmann, Aquazoo Düsseldorf
Gunther Nogge, Cologne Zoo
Ulrich Schürer, Wuppertal Zoo
Greece
Andreas Sioulas, Rhodes Aquarium
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Miklós Persányi, Budapest Zoo
Ireland
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Gloria Svampa Garibaldi, Punta Verde Zoo
Latvia
Rolands Greizins, Riga Zoo
Lithuania
Alvydas Jakevicius, Kaunas Zoo
Netherlands
Leobert de Boer, Apenheul Primate Park
Ton Dorresteyn, Rotterdam Zoo
Norway
Edvard Moseid, Kristiansand Zoo
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Vladimir V. Spitsin, Moscow Zoo
Slovakia
Miloslava Savelová, Bratislava Zoo
Slovenia
Vesel Vojko, Ljubljana Zoo
Spain
Esteve Tomàs, Barcelona Zoo
Sweden
Hans-Ove Larsson, Skansen Foundation
Switzerland
Felix Weber, Goldau Zoo
Turkey
Aydan Tekin, Bosphorus Zoo
Ukraine
Leonid A. Tsukanov, Nikolaev Zoo
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Jo Gipps, London Zoo
Ken J. Sims, Thrigby Hall Wildlife Gardens
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Dominique A. Tropeano, Colchester Zoo