SPECIAL EDITION BASED ON THE 6TH EUROPEAN ZOO NUTRITION CONFERENCE

ZOOQUARIA

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NUTRITION NEWS

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EZNC 2012
NEXT NUTRITION CONFERENCE IN ZURICH

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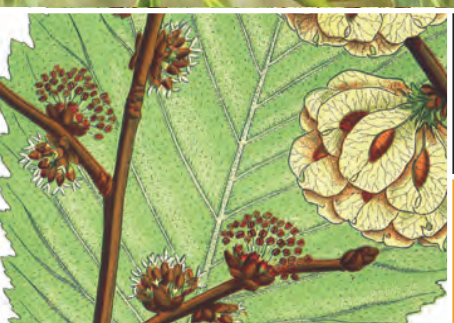

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VICTORIA OGILVY

EAZA Zooquaria Nutrition News

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VICTORIA OGILVY

From the EAZA Nutrition Group

It is my great pleasure to introduce once again a special nutrition-themed issue of *Zooquaria*, the official newsletter for EAZA. Based on papers and posters presented at the 6th European Zoo Nutrition Conference organised by ConZOOlting and the EAZA Nutrition Group, in collaboration with Barcelona Zoo, it presents issues of relevance and importance to zoo animal nutrition management, in an easily digested form (if you'll excuse the pun!).

The EAZA Nutrition Group aims 'to promote and support nutrition in zoological institutions as an essential component of their conservation mission'. Nutrition is a vital element of animal care and gathering everyone who should be talking to each other about this, namely animal keepers, vets, feed companies and researchers studying these species in their natural habitat, in one place to exchange information and ideas helps fulfil our objective. And so it was that in January 2010, more than 100 animal experts from across the globe were given food for thought at the 6th European Zoo Nutrition Conference.

The conference started with a visit to Barcelona Zoo, which also provided the setting for an elegant icebreaker and wonderful Catalan cuisine. Thereafter the group moved to the coastal enclave of Castelldefels near Barcelona in Spain. Nutrition of corals, jellyfish, salamanders and other amphibians made their first appearance alongside studies of parrots, pigeons, penguins, maned wolves, camels, cheetah, giant anteaters and many others. Although participants came from many countries within Europe, submission authors were largely from Belgium, The Netherlands, Switzerland and the UK, a list of countries we hope will expand as the conference series continues. The conference abstract book is freely available to download in electronic form from the nutrition area of the EAZA website (www.eaza.net).

New for this conference was a 'Diet Change Experiences' session, where participants summarised their practical experience of modifying diets. Speakers explained why they considered the transition a success, a failure, or could not yet tell and the case studies included modifying diets for tortoises, assessing hand-rearing diet for swifts, and bear weight management programmes at three different collections. Based on feedback from participants, the session will become a permanent feature of future meetings, serving as a means of getting science into practice.

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The conference is held approximately every two years. Previous zoo hosts include Rotterdam, Antwerp, Leipzig and Chester, and the University of Zurich is hosting the next meeting (see details at the back of this newsletter).

A huge thank you to Helena Marquès (ConZOOlting) and her team for organising another wonderful conference, to everyone at the EAZA Executive Office for their guidance and support, and finally to Joeke Nijboer, Marcus Clauss, Tjalling Huisman and Geert Janssens for editorial contributions to this newsletter.

We hope this special edition newsletter serves not only as a review of the previous zoo nutrition conference, but also as a fitting appetiser for the next one and very much hope you will join us in Zurich in 2012.

Check the website http://www.eaza.net/activities/Pages/NutritionConference.aspx regularly for further information on the conference.

Andrea Fidgett
Nutritionist, Chester Zoo
Chair, EAZA Nutrition Group

Keeping the costs down

THE RESULTS OF RESEARCH INTO METHODS OF LOWERING DIET COSTS IN TWO SPANISH ZOOLOGICAL INSTITUTIONS

Helena Marquès and Andrea Rodríguez, ConZOOlting Wildlife Management, Barcelona

In the zoo community, there are currently several assumptions that relate to the nutrition of captive wild animals:

- Formulating a nutritionally complete diet for any given species will increase the price of the diet;
- Specialised commercial food products increase diet costs significantly;
- Having a nutritionist (in-house or consultant) is a luxury that only a few can afford.

Additionally, the use of a nutritionist or a specialised professional is often questioned because:

- Information about diets is usually freely available, since zoos share information;
- Animals often survive and reproduce on inappropriate diets, which are then adopted as good diets and passed along;
- Nutrition is seen simply as choosing from a list of ingredients, based on internet and literature information on ingredients (not nutrients) eaten in the wild;
- Human traditional knowledge and beliefs related to nutrition are applied to zoo animals independently of physiology and morphology of the particular species;
- Once diets are formulated, the nutritionists have finished their job.

Furthermore the economic cost of animal diets seems to be an important factor for most institutions holding wildlife, especially today.

Taking these facts into consideration, we tried to determine whether it would be possible to assure both an adequate diet for the animals and a decrease of the diet costs. In order to do so, we analysed the diets of two Spanish zoological institutions, A and B.

WORKING PROCESS

Institution A contacted us to evaluate and reformulate the diets of its bird collection, and also to reduce diet costs whenever possible. The diets were reviewed through an intake study. A ConZOOlting team visited the centre and determined the total amount of food offered and rejected. A total of 39 diets were evaluated (for over 155 individuals) from 10 different orders (30.8% Psittaciformes, 30.8% Passeriformes and 38.4% others). Animals were housed in outside and inside enclosures, and there were a few mixed species exhibits.

At institution B, we focused on primate diets (*Macaca fascicularis*, *Lemur catta*, *Hylobates muelleri*, *Chlorocebus aethiops*, *Mandrillus sphinx* and *Pan troglodytes*). The institution's main aim was to reduce costs and introduce a commercial primate biscuit. In this case, a visit was not included and all the communication was done through telephone and email. The technical staff of the centre sent all the information we needed for determining the animals' food intake and to evaluate the diets.

All data collected in both institutions was processed and analysed using our own diet evaluation spreadsheets. Results from diet analysis were compared to nutrient requirements established for each group based on available literature.

RESULTS

Institution A: reducing leftovers saves money

All diets consisted of at least 15 different ingredients. The intake studies showed that the birds rejected an average of 39% (0%-87%) of the total food offered. The species that had more leftovers were those from the families Passeriformes and Psittaciformes, with an average of 59.5% and 43.4% of leftovers respectively. The individuals or groups housed indoors, where pests (like wild birds and rodents) had less access to food trays, had more leftovers than the animals housed in outside enclosures. For instance, Amazon parrots housed indoors left an average of 79.12% of the seed mixture versus 30.1% left by the Amazon parrots housed outdoors.

The great amount of leftovers represented almost €9.600 per year, 42% of the costs of these diets.

After conducting the diet analysis, it was found that both diets offered and diets consumed presented between two and eight nutritional deficiencies, especially in minerals and fat-soluble vitamins when compared to the nutrient requirements established for each species. Additionally, several diets were too high in fat content. The excess of food allowed selection from the animals, which did not lead to a balanced diet in any case.

With these results, diets were reformulated to meet the probable nutrient requirements established for each species and group. Basically, four recommendations were carried out:

1 In most of the diets, the commercial food was changed to a high quality product that more closely met the probable nutrient requirements of the species (incorporated at 15%-30% of the diet). This product provided a known constant nutrient supply throughout the period, allowing us to reduce the total amount of food offered, and simplify the diets by reducing the number of ingredients.
2 The other diet ingredients were adjusted and changed (when appropriate) to more closely meet the species' feeding strategy. The ingredients barely consumed by the animals were evaluated and when not necessary were eliminated.
3 Many diets were reformulated with weekly rotations of several ingredients, to reduce preparation time and encourage animals to consume less preferred diet items.
4 The total amount of food was adjusted to the energy consumed by the given group or individual, unless the animals were found to be overweight or underweight. When the animals were housed outdoors, the diet was increased by 10%-15% to account for intake by pests (although a recommendation was made to make the appropriate changes in the enclosures to minimise access to food for pests).

All these changes led to a decrease

in the cost of the diets with an average 54% decrease compared to the initial costs. In only in a few cases did the recommended diet turn out to be more expensive than the previous diet, such as for some Columbiformes and Coraciiformes.

Institution B: good quality concentrates do not increase diet costs

The diets offered at Institution B were exactly the same for all the species and contained 16 different ingredients, some of which required cooking. Although an intake study was not performed, the technical staff were asked to rate consumption of every food item in a five-point scale from 0% to 100%. According to the institution, all groups consumed almost 100% of their diet. It was noted that the diets sometimes included food from the restaurant, which could not be assessed.

Diet analysis revealed that there were at least 13 nutritional deficiencies and up to 17 when compared to the nutritional requirements estimated for each species (based on primate NRC, 2003). The deficiencies included vitamin E, several B vitamins and many minerals.

In this case, all the diets were reformulated based on each species' nutritional strategy and requirements. The incorporation of a high quality pellet (15%-25% of the diet), provided a known constant nutritional base, which allowed the elimination of several ingredients from the diets (especially of the most expensive ones which also required the greatest preparation time), and to reduce the amount of fresh ingredients.

Although in this case the costs of the diets could not be reduced significantly (only by 2%), the evaluation of the diet showed that the use of commercial feed was possible without increasing total diet costs. Many institutions that decide to include a commercial feed just add it to the diet without making any adjustments and, thus, the diet costs increase.

Due to the lack of empirical data, the amount of food offered was based on the energy requirement for the species found in literature. Diet calculations were based on mean species weight according to literature.

POINTS FOR CONSIDERATION

The work tackled in these two institutions was only partially successful. When visits were not included in the contract (as in institution B), it was very difficult to assess the nutritional status of the animals, as well as other aspects related to the feeding and nutrition of each species. Intake studies proved to be highly valuable in determining real consumption and learning about the animals' preferences and selection of the offered diet. Additionally, the assessment on-site enabled aspects related to the food storage and handling to be addressed, which was crucial for optimising diet preparation as well as reducing potential hazards.

The lack of long-term commitment by either of the institutions presented here (in both institutions there were political/staff changes before the work was finished), conditioned the success and the completition of the work. Additionally, long-term commitment is necessary in order to assist in diet transitions and assess whether the recommendations have the desired effect. Moreover, zoos are not static and, thus, there are several factors that imply that diets are also not static but dynamic. Some of these factors are the frequent changes in animal groups (not only in numbers of animals, but also in physiological state), the constant move of staff, market availability of food items, supplier reliability, and financial constraints.

It is also important to note that sometimes, in order to decrease costs and make diet preparation more efficient, it is necessary to restructure and reorganise diet preparation areas in order to optimise changes and be successful. This was the case in institution A. Some of the changes could be seen as an obstacle at first (such as weighing out all ingredients during diet preparation), but at the end they save time and, in many cases, money.

Therefore, in order to be successful in a diet revision process, the work should include not only diet formulation, but also a revision of the organisation of the commissary, stock control, costs review, solving daily problems related to the feeding of the animal collection, and acting as a link between the staff involved in different stages of the animal feeding (curators, keepers, commissary staff and vets).

CONCLUSIONS

With the experiences in the two centres, we conclude that it is possible to decrease diet costs (at least for primates and birds) without compromising the nutritional status of the animals. However, in order to do so, the collaboration of the technical staff and keepers and a long-term commitment by the institution is necessary.

Food colouring for frogs

WHAT DO DIFFERENCES IN CAROTENOID ACCUMULATION AMONG THREE FEEDER-CRICKET SPECIES MEAN FOR DIETARY DELIVERY OF COLOUR TO CAPTIVE INSECTIVORES?

Victoria Ogilvy and Richard Preziosi, University of Manchester; Douglas Sherriff and Andrea Fidgett, Chester Zoo

There have been various anecdotal reports of captive anurans (frogs and toads) appearing less colourful, particularly with respect to yellow, orange and red pigmentation. In nature, these colours are typically produced by carotenoids, a large family of biologically active pigments synthesised by plants, bacteria and fungi. Carotenoids are the reason why tomatoes are red, carrots are orange and sweetcorn or maize is yellow. Vertebrates cannot synthesise carotenoids themselves and therefore rely entirely on dietary sources, so colour degradation in frogs and toads may be caused by limited carotenoid availability in the diet. Carotenoids may influence health and reproduction due to their roles in immune and antioxidant systems in many taxa, yet their importance for anurans is poorly understood. Furthermore, carotenoid-based colouration is often used for sexual or anti-predator signalling. Reduced colouration in captive anurans could indicate poor health, with consequent implications for reproductive success in captivity and suitability for reintroduction to the wild.

Wild insectivores consume a broad range of invertebrates that have fed on a wide variety of food items. They may also alter their prey selection during different stages of their life-history in order to meet differential nutritional needs. For insectivores in captivity, the choice of feeder-invertebrate species is more limited and many are known to be deficient in certain key nutrients. The nutritional value of feeder-invertebrates may be improved by providing them with an enriched diet (termed gut-loading), the objective being that specific nutrients required by the insectivore remain in the gastrointestinal tract of the invertebrate before it is consumed. Most anurans are insectivorous and feeding behaviour in frogs is typically triggered by the movement of prey

ISTOCKPHOTO

items across their field of view; sessile prey is less likely to be consumed. So from an already reduced range of prey options, the types suitable for frogs are further limited by their detection ability and gape size.

Many studies have shown gut-loading to be an efficient method for altering the nutritional composition of feeder-invertebrates (specifically minerals such as calcium and phosphorous), however analyses of carotenoid composition are rarely included in these studies. Moreover, comparisons of gut-loading between feeder-invertebrate species have generally included taxonomically and morphologically distinct species such as house crickets (*Acheta domesticus*) and mealworms (*Tenebrio molitor*). There have been few studies that compare gut-loading among closely related feeder-invertebrate species.

This is relevant to insectivorous species that are restricted in the types of feeder-invertebrates on which they can feed. For example, crickets form a substantial portion of the diet for tree frogs (family *Hylidae*) and several feeder-cricket species are commercially available. While investigating the role that colour plays in fitness and fertility of these frogs, we wanted to determine whether species of crickets differ in terms of their ability to gut-load carotenoids.

We carried out an analysis of carotenoid composition of crickets that are typically fed to captive anurans to assess variation in gut-loading capacity. We also sought to determine which diet delivered the highest nutritional value in terms of carotenoids, and to assess carotenoid retention following a period of starvation.

COMMON PRACTICE

An informal survey was carried out across EAZA members to determine which prey items are most commonly fed to captive frogs. The responses received revealed that the three most commonly used species were black crickets (*Gryllus bimaculatus*), tropical/banded/brown crickets (*Gryllodes sigillatus*) and house crickets (*A. domesticus*), and therefore these three species were used in our study. Crickets were fed for four days on one of three diets (bran, fresh fruit and vegetable, fish food-based dry diet) all of which are used to maintain and gut-load crickets before they are fed to captive frogs. The experimental period replicated a typical period of gut-loading before feeding to the target species. Following this, half of the crickets from each treatment were fasted for two days to assess carotenoid retention. The fasting period simulates feeding in the captive environment and 'empty-gut' crickets represent individuals that are present in insectivore enclosures for some time before they are consumed, or crickets that are not maintained on a gut-loading diet immediately prior to use.

Each species was, itself, a very poor source of carotenoids; however, we found that the carotenoid content of feeder-crickets could be improved through gut-loading with carotenoid-rich foods, though the concentration of carotenoids (per given weight of

AGALYCHNIS CALLIDRYAS, FROGS FADE ON ZOO DIETS OF CRICKETS (LEFT), BUT THOSE FED PREY ITEMS WHICH ARE GUT-LOADED WITH CAROTENOIDS ARE MORE BRIGHTLY COLOURED (RIGHT)

VICTORIA OGILVY

cricket) varies between species. An analysis of crickets fed the fish food diet showed G. *bimaculatus* crickets to have a significantly higher total carotenoid concentration (per unit body mass) than G. *sigillatus* or A. *domesticus*. Therefore, insectivores that consume G. *bimaculatus* crickets gut-loaded on carotenoid-rich foods are likely to have a higher intake of carotenoids than if they were fed A. *domesticus* or G. *sigillatus* gut-loaded crickets.

All fasted or 'empty gut' crickets had significantly reduced total carotenoid concentrations suggesting they have poor carotenoid retention and storage capabilities. Their carotenoid content will therefore be significantly reduced if they remain uneaten for 48 hours or more. Making carotenoid-rich foods available within enclosures for feeder-crickets to eat could improve this; however, it may be impractical and foods may not be consumed by the prey items in a timely fashion. Captive insectivores should therefore be provided with freshly gut-loaded prey items that have had access to food within the last 48 hours, and uneaten prey should be removed to prevent predators from becoming satiated on non-gut-loaded prey.

Feeder-crickets from commercial suppliers are typically despatched with a wheat-bran food source. We found only trace levels of lutein and carotene in these animals, making them a poor source of carotenoids and captive insectivores fed solely on bran-fed crickets are therefore likely to have negligible access to the pigments.

TO SUMMARISE:

- Under the fish-food based diet treatment, black crickets (G. *bimaculatus*) had the greatest total concentration of carotenoids out of the three feeder-cricket species tested, and would therefore be the more favourable species to use as a vehicle for delivery of carotenoids.
- For carotenoids to be included in the diet of captive obligate-insectivores, crickets should be fed a carotenoid-rich diet, such as fresh fruit and vegetables. Captive insectivores that are provided with crickets fed wheat-bran alone are likely to have limited access to carotenoids.
- All feeder-cricket species tested had very low carotenoid concentrations following a period of fasting, which suggests they have a limited ability to sequester carotenoids into their body tissues. Captive insectivores should therefore be provided with freshly gut-loaded crickets if carotenoid intake is to be optimised.

The nutrients available in the diet of wild insectivores are determined by the body composition of the invertebrates that they feed on, plus the nutrients present in the digestive tracts of those invertebrates. The diet of wild invertebrates is therefore likely to be diverse and replication in captivity is problematic. Gut-loading of invertebrates can be used to diversify the nutrients present in the diet of captive insectivores; however the efficacy of gut-loading may vary among closely related species. Furthermore, since carotenoids are synthesised by plants, bacteria and fungi alone, and since crickets appear to have limited capacity for carotenoid absorption, gut-loading with carotenoid-rich foods is likely to be the most effective method for incorporating carotenoids as part of a balanced diet for captive obligate-insectivores. The consequences of receiving a carotenoid-limited diet are unknown for many insectivores; nevertheless, the benefits of dietary carotenoids on health and reproduction have been demonstrated in many species. Further research into the importance of carotenoids for the health and reproductive success of obligate-insectivores in captivity would be valuable.

FURTHER READING:

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What's the score?

BODY CONDITION SCORING AS AN EASY METHOD FOR ASSESSING THE EFFICACY OF DIET CHANGES IN HOOFSTOCK

Thijs van den Houten, student, Van Hall Larenstein and Andrea Fidgett, Nutritionist, Chester Zoo

ANDREA FIDGETT

What are body condition scores?

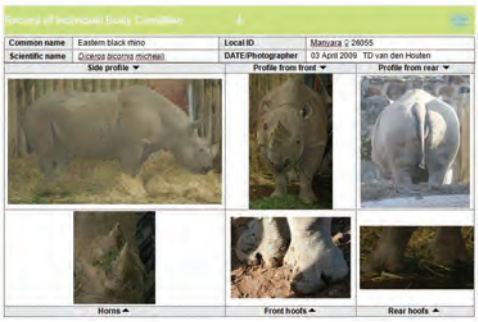
Body condition refers to the amount of fat that an animal is carrying. Body condition scoring is a system designed to estimate the amount of fat that an animal has, so scoring systems are based on body shape, outline or silhouette, the prominence of skeletal features, and the fat and muscle overlaying various body parts. When an animal is losing condition, fat reserves are mobilised and muscle wasting sets in to supply the required energy demand. Body scores have been used in the domestic hoofstock industry for many years and developed for horses, goats, sheep, cattle and pigs to name a few, and have been found useful in judging the adequacy of energy supplies. In recent years there has been a trend to use body condition scores in a wide variety of captive animals in conjunction with regular weighing wherever possible, as a means of improving the quality of animal care.

Scoring systems typically are designed around a 3, 5, 7 or 9-point scale and most assign the lowest number to a severely underweight or emaciated condition, and the highest number to animals that are severely overweight or obese. The middle point in the scores is considered the ideal condition. Such systems are useful when assessing an animal's body condition; however it is important that additional factors such as the animal's body weight, frame size, pregnancy, lactation, season and general health should also be taken into consideration when translating the score into a judgment. Using objective and standardised body condition scores, an animal's appearance and/or condition can be described very effectively and, particularly useful for zoo animals, tracked over time. Thus, body condition scores lend themselves to assessing the impact of dietary changes.

DISNEY'S ANIMAL KINGDOM

Case study: using body condition scoring to assess hoofstock diet changes at Chester Zoo

An evaluation of Chester Zoo's diets for hoofstock species conducted in



2006 revealed that the diets were overcomplicated. The dry feed portion alone comprised varying combinations of 16 products including pellets, 'straight' feed ingredients (eg bran, flaked maize) and supplements. Diets fed to the hoofstock species were based on information sent with animals when they arrived from another collection, combined with trial and error use of existing food ingredients available and experience of what worked for similar species. Few health problems were evident; however, there was no consistent rationale within the collection for feeding these species.

Since 2007 hoofstock diets now take account of digestive anatomy, feeding ecology and life stage, with an emphasis on forage, and dry feeds rationalised to just three specially formulated concentrates, eliminating the necessity for any additional supplements. Immediate acceptability of the adjusted diets by animals was good, with a month-long transition to ensure minimal disruption to gastro-intestinal function. Assessment over a longer period was necessary to ensure continued efficacy of the hoofstock diets. Are the diets that are currently fed to all hoofstock species adequate for optimal health and welfare?

Approximately three years after the diet changes, diet assessment was based on a combination of interviews with the head keepers of the relevant sections and by body condition scoring their animals. Head keepers were asked to confirm current feeding practices, whether there were health problems which may be diet-related and how the current diet is accepted by the animals. Aside from some adjustments to pellet quantity, no significant concerns were reported. Body condition scoring was used to measure diet efficiency visually, using 5-point, species-specific systems already developed for the relevant or closely-related species. Digital photographs were also taken to create profiles for individually identifiable animals, creating an electronic archive that will be used to track condition changes over time. The condition for almost all animals was scored to be ideal or close to this value; notable exceptions were females presumed (and later confirmed) to be pregnant.

Providing that standardised systems for scoring can be agreed, body condition scoring is a low-tech, non-invasive yet effective tool for zoo animal management and for assessing the efficacy of diet changes in particular.

Score	1: Emaciated	2: Thin	3: Fair	4: Good	5: Heavy
Outline Depictions					
Neck & Shoulders	• Neck is narrow and angular (bony) • Nuchal ligament prominent • Prescapular groove deep and obvious • Shoulders are angular, bony	• Neck is flat and narrow • Nuchal ligament visible • Prescapular groove is obvious • Shoulders are flat and slightly bony	• Neck is rounded • Prescapular groove is slightly visible • Shoulders are flat.	• Neck is well muscled and rounded • Shoulders are rounded	• Neck is thick, well muscled, and rounded • Shoulders are well muscled and rounded
Scapula & Ribs	• Scapula and ribs are very obvious	• Scapula and ribs are obvious	• Scapula and ribs visible	• Scapula is covered • Ribs are covered (skin folds)	• Scapula is covered • Ribs are well covered (skin folds)
Spine	• Groove along backbone is very obvious • Spinous processes are very prominent	• Deep groove along backbone obvious • Spinous processes are prominent	• Groove along backbone visible • Spinous processes are visible.	• Backbone is slightly angular • Spinous processes are slightly visible	• Backbone is rounded • Spinous processes are covered.
Rump & Tail Base	• Obvious depression in the rump • Pelvic bones are very prominent • Tail base is very thin and bony	• Rump is concave • Pelvic bones are prominent • Tail base is slightly bony	• Rump is slightly concave • Pelvic bones are visible • Tail base is narrow	• Rump is flattened • Pelvic bones are slightly visible • Tail base is rounded	• Rump is well rounded • Pelvic bones are covered • Tail base is rounded (bulging)
Abdomen	• Abdomen is tucked in • Flank folds are obvious	• Abdomen is tucked in • Flank folds are visible	• Abdomen is slightly tucked in • Flank folds are slightly visible.	• Abdomen is filled • Flank folds sometimes slightly visible	• Abdomen is distended and taught • No visible flank folds

Table 6: Summary of Body Condition Scores for Black Rhinoceros

Responsible feed in zoos

WHAT DOES DEFORESTATION HAVE TO DO WITH FISH FEED? DOES *EX SITU* CONSERVATION HAVE NEGATIVE EFFECTS ON *IN SITU* CONSERVATION?

Daan Wensing and Laurens Gomes, IUCN Netherlands

Animal feed contains all sorts of ingredients that are not commonly considered in sustainability policies. An example: in Europe animal feed producers use soy as a major source of protein. After the ban of Meat and Bone Meal (MBM) following the BSE crisis, animal feed producers had to use a new protein source. The cheap protein-rich soybean proved to be the best candidate. Europe does not produce significant tonnage of soy due to two major trade treaties: there are no import tariffs on oil seeds (including soy) and the limits that are set in Europe for the designation of land used for oil seed production. For example, the number of hectares needed to produce the soy imported in The Netherlands alone is almost equal to the total area available in Europe for oil seed production.

SOY

Soy originates from China, but the bulk of the soy used in animal feed in Europe and China is produced in South America. In the 1970s, soy production in Brazil and later Argentina, Paraguay and Bolivia expanded, often resulting in conversion of natural habitat such as rainforests. For 2010 the total area under soybean production in Brazil alone was estimated at 22 million hectares and this is expected to increase to 30 million hectares. This expansion of production has yielded many economic and some social benefits for the producing countries, though also at high environmental and social costs. Soy plantations have been established in ecosystems such as the Chaco, Cerrado, Atlantic Rainforest and Amazon. Expanding soy production has also resulted in a 'push' of other land uses (like cattle ranching) into nature areas.

Other issues at stake include worker rights, erosion, land rights and pesticide use.

CERTIFICATION

Over the past years several certification schemes have been developed for more responsible production of soy. In the beginning, COOP and WWF developed the 'Basel' standard; setting criteria to prevent deforestation and protect worker rights, amongst others. Additionally, the soy certified as Basel soy excludes genetically modified soy (GM soy). The European soy industry has seen some examples of companies that made the bold move to start sourcing Basel soy instead of conventional soy. However, the majority focuses on the multi-stakeholder platform of the Round Table on Responsible Soy (RTRS). The RTRS consists of producers, industry and NGOs who work on a certification scheme that allows benefits to all stakeholders and offers a mainstream solution to the market.

ACTION

The tonnage of certified soy entering the European market is expanding, but not at a scale that will make an impact or, for example, help stop conversion of natural areas in South America. Action is therefore needed. This need for action has resulted in a unique partnership in The Netherlands between the IUCN National Committee of the Netherlands (IUCN NL) and its member organisation the Federation of Dutch Zoos (NVD). In a bold statement the boards of all zoos (14 in total) decided that they no longer wanted to be part of a production system that threatens biodiversity around the globe. As of November 2010 all soy that is needed for the production of animal feed in the Dutch zoos is independently certified according to the Basel criteria, ensuring that all certified soy does not cause deforestation, social issues, pollution and erosion.

The soy tonnage used by zoos is not the largest, but the statement is very powerful: we protect animals in our zoos, educate our visitors and the next generation and also want to support conservation by sourcing the right material. The Dutch zoos attract over 10 million visitors a year and they can now experience a positive nature

DAAN WENSING IUCN NL

DEFORESTATION FOR SOY PRODUCTION AT MATO GROSSO, BRAZIL: JAN GILHUIS, SOLIDARIDAD

conservation contribution. Media such as the Dutch Youth News and national newspapers covered the statement, widening the scope of the result.

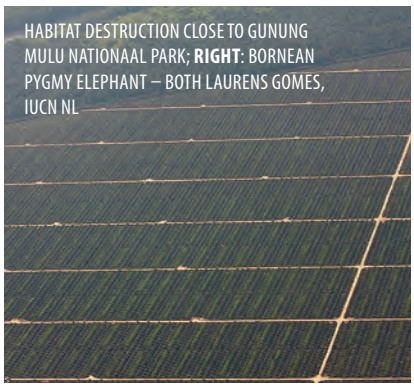
EXPANDING COOPERATION

After the success of the cooperation on soy, the IUCN National Committee of The Netherlands and three Dutch front-runner zoos (Blijdorp, Artis and Burgers') have expanded their cooperation. Supported by the Dutch government, an analysis was made on high-impact components in animal feed as well as products served in the zoos' restaurants. Examples of ingredients that have significant impacts on biodiversity and ecosystems around the globe include: palm oil (in feed and use in restaurants), fish (feed and restaurants), and meat. Why these ingredients?

PALM OIL

Palm oil is an ingredient included in almost 70% of the products in Dutch supermarkets. The oil is used in deodorants, biscuits, soap, butter, etc. And as with soy, very few consumers know this. Yes, there are some products that obviously contain palm oil, but the average consumer is not aware of the fact that their favourite biscuit contains palm oil. By consuming palm oil, the rainforests in South-East Asia suffer, being sacrificed to produce almost 85% of the global palm oil production. Large tracts of rainforest have been deforested to support oil palm plantations with almost 15 million hectares around the world covered by palm oil resulting in major impacts on biodiversity.

Many species, like the orang-utan, Sumatran tiger and Sumatran rhino are suffering from deforestation. As most plantations are established on peatland that needs to be drained – resulting in enormous CO_2 emissions – the carbon impact is also substantial. The rest of the tropical world is catching up fast, with enormous tracts of land destined for oil palm plantations in Colombia, Brazil and tropical Africa. This is why Dutch zoos and IUCN NL are now investigating how to replace the palm oil used in animal feed and (for example) in frying oil with sustainably produced palm oil. Like with soy, international certification schemes exist, of which the Round Table on Sustainable Palm Oil (RSPO) is the major one.



HABITAT DESTRUCTION CLOSE TO GUNUNG MULU NATIONAAL PARK; **RIGHT**: BORNEAN PYGMY ELEPHANT – BOTH LAURENS GOMES, IUCN NL

We want to support conservation by sourcing the right materials

FISH

Headlines appear frequently about over-fishing. Media reports often ask the cynical question: who will catch the last tuna? Fish stocks all over the world are being depleted at unprecedented speed and immediate action is needed to prevent further collapse of stocks. Certification schemes are being put in place to allow for sustainable fishing. Conservation NGOs have developed lists of fish species related to area of origin that stipulate which fish to eat and which not. Dutch zoos are now developing an action plan in cooperation with IUCN NL to identify the fish species that can be responsibly used as animal food as well as in the restaurants. This is a clear signal, also to the visitors of zoos who will be educated on the importance of conserving fish species and stocks.

Fishmeal is also used in animal feed and, again, many sustainability issues arise. For example: many aquaculture fish are fed soy. Yes, the same soy that stems from South America. And fish are fed to fish, again creating unsustainable production systems, because declining wild fish stocks are fed to aquaculture fish. The issue of sustainable feed is therefore complicated and needs thorough analysis in order to take the right steps and make a real contribution to lessening the ecological footprint.

MEAT

Finally, Dutch zoos seek sustainable alternatives to the meat used as animal feed and served in their restaurants. In The Netherlands, almost all commercially produced meat is obtained from animals fed on a diet including soy. There are many other sustainability issues like animal welfare which also play a huge role and need to be addressed in relation to meat. The research now focuses on procurement possibilities of sustainably produced meat, for example from organic farms and conservation areas that have excess animals due to range limitations.

FUTURE

The Netherlands is the largest importer of both soy and palm oil in Europe. A substantial portion of the imports is exported (either directly or after processing) to other European countries, resulting in a shared responsibility. Dutch zoos show that installing a sustainability procurement policy can yield positive results. Not only is there an incentive in the market to produce sustainably to meet the demand, but the signal that zoos are daring to act is an example to others that procure the same ingredients and products. No zoo or company wants to contribute directly or indirectly to biodiversity and ecosystem loss and there is an opportunity to act now. Much still needs to be investigated, but certification systems do exist and it is possible to replace the unsustainable ingredients in animal feed like soy, palm oil, fish meal and fish with sustainable alternatives.

Locally produced alternatives instead of sustainable produced ingredients from abroad are part of the options we all have.

Managing zoo diet information

WHAT DO WE NEED FROM THE NEXT GENERATION OF SOFTWARE?

Andrea Fidgett, Chair, EAZA Nutrition Group and Merryl Webster, Format International

We all want to feed our animals well. Yet within zoos and aquariums different stakeholders concentrate on different aspects of feeding; some may be mostly concerned with the nutrient content, others with the way food is presented. The physical and behavioural health of animals may be a principal focus and sustainability, efficiency and costs are becoming increasingly significant drivers. Obviously all of these aspects require consideration to achieve the initial premise of 'wanting to feed our animals well'. Sharing knowledge about best feeding practice can improve global management of living collections, with anecdotal descriptions replaced by meticulous observation, documentation and analysis. Recording and cataloguing feeding practices and the outcome of adjustments, along with the means for systematic retrieval of said records at some later point in time, would represent a significant advance in the evaluation and dissemination of effective feeding practice. But how can this vision be achieved?

GENERAL REQUIREMENTS FOR DIET SOFTWARE

There is a gap within the current suite of software provided by International Species Information System (ISIS); the facility to record diet notes is currently available within both the Animal Records Keeping System (ARKS) but as it is a free text box, it can completed with varying attention to detail. Bespoke software designed for the zoo community could:

- ensure diet information is stored in a rigorous, standardised format
- be linked with animal stock numbers, allowing comparison with food purchasing/accounts
- be used for diet formulation, permitting the exchange of true 'diet' data – the nutrients that are being offered and consumed in specific quantities, not just a list of the food ingredients involved
- allow easy collation of diets used for many species at a single collection thereby fulfilling criteria for legal purposes or professional accreditation.

Furthermore, diet information for a single species held in many collections could be easily collated, providing a useful research tool for producing zoo husbandry guidelines; it could also be a valuable educational tool. Pragmatic reasons for using a customised diet management program include legislative drivers, plus economic incentives (eg the facility to check that the quantity of food that should be fed matches what is being ordered).

DESIGN AND DEVELOPMENT OF NEW SOFTWARE

A number of programs currently in use offer some of the functionality described, but none can do all of the above. Also, with no investment or management evident, all of these programs are becoming technically obsolete and incompatible with modern technology. With ISIS deploying the Zoological Information Management System (ZIMS) in 2010, it was timely to consider the design and build of a single, zoo diet information management program which at a future date might 'plug-in' to the ISIS software suite. A group of like-minded individuals, members of the EAZA Nutrition Group and AZA's Nutrition Advisory Group, were invited to a short workshop in advance of the 6th European Zoo Nutrition Conference held in Barcelona last January. Their task was to discuss if and how we might work together to design and build the next generation software. Key questions to address were: who are the main contributors to what and how animals get fed, what information do they need to feed their animals effectively, and what can be done to optimise animal feeding in zoos?

Who are the main contributors to what and how animals get fed?

Workshop participants suggested many contributors to what and how animals are fed, using terminology which reflected actual job functions not job titles. For example, it was recognised that in many zoos vets act as nutritionists, and the curators are usually also budget holders. The most influential contributors were considered to be:

- animal keepers
- curators/head keepers
- budget holders
- commissaries (ie feed purchasing/storage/delivery)
- nutritionists
- consultants/professional network
- species managers (eg EEP/SSP/TAGs)
- vets (as clinicians)

The remainder of the workshop focused on what the most influential stakeholders would need to know or consider in order to feed animals as effectively as possible.

What information is needed to feed animals effectively?

The group reviewed and added to more than 30 questions or 'information needs' produced by interviewing staff in the various roles noted above. Examples are listed here:

- What do I put in the animal's food bowl (ingredients, quantity, all aspects of presentation and how it varies with time)?
- Has there been any diet drift (in terms of ingredients, quantity)?
- What does this species require (over time, season, life stage, ability to adjust this as more research data on requirements becomes available)?
- What ingredients are available (equivalents, seasonality, location, availability)?
- What is the chemical composition of ingredient/diet?
- How do ingredients compare (between suppliers, wild data, season, with published values)?
- How do diets compare (between or within collections, with historic data, wild data, recommendations?

WORKSHOP PARTICIPANTS SUGGESTING WHO ARE THE MAIN CONTRIBUTORS TO WHAT ANIMALS ARE FED

- What food do I need to order (specific ingredients, quantity/volume, frequency/storage)?
- Can all the stock purchased be accounted for (ie does what is purchased match what is issued)?
- What does this diet cost (for an individual species/time period or in terms of ingredients varying over time, trends: to include labour and equipment costs)?
- Do my spending patterns differ from predicted – if so, how and why?
- How can I reduce costs (a) via ingredient substitutions, feed equivalences (b) via changing supplier, purchasing power?
- Are there ethical considerations in feeding this diet (eg palm oil/live prey etc)?

The importance of each of these was prioritised as either essential, desirable or of little importance for each of the most influential contributors to zoo animal feeding. Results help developers of future diet management tools to focus their efforts on meeting the priority needs of the people with most influence over animal feeding. Existing software applications known to participants were reviewed specifically to assess how well the capabilities of these programs matched the main questions/issues identified as essential. Most cope with needs associated with diet formulation but none were able to meet all or even the majority of the essential needs listed above.

We agreed that the development of a new generation of diet management tools was desirable, necessary and also rather urgent. A fundamental part of the toolkit is targeted training and education specificity to stakeholder needs (see article by Huisman *et al* in this newsletter). Additionally we stipulated that any software application developed must be intuitive, clear and attractive to use. Zoo nutrition is championed by a wide variety of different people in different institutions and tools must be accessible for them to be both useful and to maintain enthusiasm.

STEERING GROUP ACTIVITIES

An 'interim' steering group formed to move this project forward and investigate additional stakeholders from other regions (tools developed have application beyond the EAZA region), potential sources of funding and technical partners. Integration with ISIS is vital, though development should be driven by the zoo nutrition community.

Since the workshop, a partnership has been forged with Format International to develop and design a bespoke software application. Based in the UK, Format International designs technical software for the food and feed industry worldwide and specialises in formulation software, recipe design, management and auditing. Having seen the list of 'needs' agreed by workshop participants, there is a good match between the functionality required for zoo nutrition and features in their standard packages. Some customisation (terminology, classification) is required which Format International is able and willing to provide.

Working together now for almost a year through a series of meetings and most recently another workshop, this time in Ghent, our vision is a zoo diet management system for all those concerned with feeding our animals well, encompassing features associated with feeding, formulation, inventory management, auditing and (ultimately) integration with ISIS. We believe it to be an achievable and exciting challenge and hope to share our progress in person at meetings of both the AZA Nutrition Advisory Group later this year and the EAZA Nutrition Group early in 2012.

Sincere thanks to all who have contributed thus far to the design process. Project updates will be posted on the EAZA Nutrition Group web page.

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Finding out about the frogs

FEEDING, BREEDING AND HABITUATION OF EXOTIC FROGS IN THE MASOALA RAINFOREST ECOSYSTEM AT ZURICH ZOO

Ragna Franz, Clinic for Zoo Animals, University of Zurich; Martin Bauert and Samuel Furrer, Zoo Zurich

Due to several reasons such as habitat loss, pollution and disease, amphibian species are more threatened than any other animal group. These problems are exacerbated by failing efforts to prevent the expansion of the deadly chytrid fungus or to treat infected individuals in the wild. Confronted with these problems, there is only one course of action: to bring the endangered amphibians to protected stations. This allows the animals to live and reproduce in a secure environment, providing that information about the correct handling and habitat conditions are available.

Zurich Zoo keeps and breeds several amphibian species. Among these are frogs endemic to Madagascar, such as the small poison frog *Mantella laevigata*. As well as intensive research into husbandry and breeding in this species, there is a plan to gradually release them from a controlled terrarium into the rainforest ecosystem. In order for this to be successful, further knowledge of feeding and social behaviours are necessary and several methods of feeding and handling of free ranging frogs are presented.

CLOCKWISE FROM TOP LEFT: *M. LAEVIGATA* HIDING IN THE ROCKS; A FEMALE AFTER EGG DEPOSITION IN AN ARTIFICIAL BREEDING OPPORTUNITY; HABITAT PROVIDED FOR *M. LAEVIGATA* IN THE EXHIBITION; EXTERNAL BREEDING STATION FOR TADPOLES

BREEDING SKILLS

M. *laevigata* is unusual when compared to other species of *Mantella*, especially in terms of reproduction, where males defend their territories and females show a primitive brood care system. Although many investigations have been carried out with regard to this species, knowledge about keeping them in captivity is limited.

This Malagasy frog has been kept in the Masoala rainforest exhibit since 2006. Almost all frogs are housed in terrariums consisting mainly of a metallic fly screen, thus exposing frogs to the same controlled tropical conditions as the rest of the exhibit. To ensure a sufficient food supply, fruit boxes are placed in the terrarium to attract surrounding flies. This allows flies to circulate freely in the terrarium and for the frogs to prey upon them, as under natural conditions; contents of the fruit boxes are changed three times a week.

For breeding, additional opportunities are offered in terms of black boxes (similar to the fruit boxes), filled with water and placed almost horizontally to the ground and into small trees (*Ficus benjamina*). The frogs accepted these artificial tree and moss holes and showed mating behaviour in and upon the boxes. After mating, females laid single eggs into the water-filled boxes and, after approximately seven days, tadpoles emerged.

Reproductive success can be increased by hand-rearing the young. Each tadpole is housed individually in a rearing tank to prevent cannibalism between tadpoles of this species, and fed three times a week with a spirulina algae product (eg Tetra PlecoMin). When the tadpoles have reached final colouration, they are ready for transfer into a small aquarium set up so that 75% of the base is filled with water and the remainder covered with rocks and moss, thus allowing recently emerged frogs to leave the water with ease. For juvenile frogs, springtails (*Collembola*) are offered daily.

It was planned to release some of the frogs into the rainforest exhibit itself and the substrates preferred by M. *laevigata* for areas such as hiding places were investigated. Large lava stones with several holes seemed to receive wide acceptance by the frogs, so a habitat was created in the exhibit consisting of these, covered with mud, moss and tree branches. Some of the adults and sub-adults were released here, where they immediately hid in the rocks and, three months later, a large adult male was observed on the top of the hill calling. Though survivorship cannot be presented here, M. *laevigata* demonstrated adaptation to new conditions, despite the many changes.

Acknowledgements

Our special thanks go to Stefan Wettstein, the head keeper in the Masoala exhibit, whose continued help has been invaluable.

6th European Zoo Nutrition Conference BARCELONA 28-31 JANUARY 2010

Thursday 28 January 2010 Barcelona Zoo	
18:00	REGISTRATION & ICEBREAKER
Friday 29 January 2010	
08.00	Registration
08.45	Welcome and opening remarks
09.00	Flexibility of the gastrointestinal tract of vertebrates *J.M. Starck, INVITED SPEAKER*
09.45	Nutrient digestibility and digestive efficiency in Livingstone's fruit bats (*Pteropus livingstonii)* *C. Schwitzer, J. Bilstra, S. Chikunya, J. B. Carroll*
10.00	A comparative view on dry matter intake and mean retention time of large herbivores *P. Steuer, K.H. Sudekum, R. Franz, J. Kaandorp, M. Clauss, J. Hummel*
10.15	Browse, grass and legumes-investigations on the digestion of different forage types *J. Hummel, K.H. Sudekum, M. Clauss*
10.30	Investigations on rumen and claw health of different wild ruminants according to the feeding management *B. Schilcher, K. Baumgartner, A. Liesegang*
10.45	BREAK for Commercial & Poster Sessions
11.30	A survey of Eastern Bongo (*Tragelaphus eurycerus isaaci*) feeding practices in UK zoological collections. *D.J. Wright, H.M.Omed, A.L. Fidgett*
11.45	It seems difficult to feed ruminant browsers adequately; the Japanese serow (*Capricornis crispus*) as yet another example *A. de Meijer, L. Mooij, M. de Jong, E. Dols, T. Huisman*
12.00	Winter feeding of captive moose (*Alces alces*) with various roughages *D.G.M. Kohlschein, J. Hummel, A. Peemoller, J.M. Hatt, M. Clauss*
12.15	Practical feeding of moose and giraffes in Kolmarden Zoo *B.O. Roken*
12.30	Nutritional quality of mid-European browse-a review *J. Hummel, M. Clauss*
13.00	LUNCH
14.30	Development of a browse identification book for zoo keepers *J. Nijboer, Tjalling Huisman, Koen van Geenen, Piko Fieggen*
14.45	Lowering diet costs in two Spanish zoological institutions *A. Rodríguez, H. Marquès*
15.00	Responsible feed in zoos *J.D. Wensing, J. Nijboer*
15.15	BREAK for Commercial & Poster Sessions

DIET CHANGE Session	
16.00	Diet reviews and adjustments for three species of tortoise (*Geochelone gigantea, G. carbonaria* and *Testudo graeca*) at Paignton Zoo Environmental Park. *M. Steele, A. Batten, A. Plowman*
16.15	Hand-Reared Common Swifts (*Apus apus*) in a Wildlife Rehabilitation Centre: Assessment of Growth Rates with Different Diets *E. Fusté, L. Olid, E. Obon*
16.30	Efficacy of hoofstock diets at Chester Zoo; assessment by keeper questionnaire and body condition scoring *T.D. van den Houten, A.L. Fidgett*
16.45	Dietary management of an obese Kinkajou (Potos flavus) with congestive heart failure secondary to hypertrophic cardiomyopathy *D. Eshar, J.A. Briscoe*
17.00	Bear weight management: a diet reduction plan for an obese spectacled bear (*Tremarctos ornatus*) *K.J. Lisi, T. L. Barnes, M.S. Edwards*
17.15	A failed attempt to change the diet of giant anteaters (*Myrmecophaga tridactyla*) *M. Clauss, T. Rothlin, S. Furrer, J.-M. Hatt*
17.30	Roundtable Discussion
Saturday 30 January 2010	
08.30	8.00 Registration
09.00	Carnivore nutrition: bones of contention *G.P.J. Janssens, INVITED SPEAKER*
09.45	Impact of diet type on fermentation rate of cheetahs in captivity *S. Depauw, M. Hesta, L. Vanhaecke, J. Schulz, B. Wuyts, G.P.J. Janssens*
10.00	Nutrient digestibility and energy evaluation in carnivorous mammals *M. Clauss, H, Kleffner, E. Kienzle*
10.15	Nutritional management of captive cheetahs; is the domestic cat an appropriate model? *K.M. Bell*
10.30	Nutritional evaluation of two milk replacers used to hand-rear cheetah cubs: nutrient composition, apparent faecal digestibility & differenced to maternal cheetah milk *K.M. Bell, S.M. Rutherfurd, W.H. Hendriks*
10.30	BREAK for Commercial & Poster Sessions
11.30	Feeding behaviour: meeting nutritional requirements and behavioural needs *X. Manteca, INVITED SPEAKER*

12.15	Identifying feeding behaviour of corals through stable isotope analysis *G. Ludevese, D. Petersen, P. Boeckx, G.P.J. Janssens*
12.30	Feeding, breeding and habituation of exotic frogs in the rainforest hall at the Zoo Zurich *R. Franz, M. Bauert, S Furrer*
13.00	LUNCH
14.30	To colour or not to colour, the role of carotenoids in animal ornamentation and health *J.J. Negro, INVITED SPEAKER*
15.15	Cricket species vary in gut loading capacity: implications for delivery of carotenoids to amphibians *V. Ogilvy, R.F. Preziosi, D. Sherriff, K. Arbuckle, A.L. Fidgett*
15.30	A preliminary study of Vitamin D3/UV-B treatments for amphibian bone disease *R. Browne; F. Vercammen, Z.. Pereboom, E. Verschooren*
15.45	BREAK for Commercial & Poster Sessions
16.15	Seed diets for psittacine birds: natural food or nutritional calamity? *I.D. Kalmar, A.C. Veys, B. Geeroms, M. Reinschmidt, D. Waugh, G. Werquin, G.P.J. Janssens*
16.30	Metaplasia caused by vitamin A deficiency in penguins? *J. Nijboer, M. Kik, W. Menger*
16.45	Feed intake strategy of breeding pigeons *G.P.J. Janssens*
17.00	Managing zoo diet information; what do we need from the next generation software? *A.L. Fidgett*
17.15	Software Discussion
20.30	Conference Dinner, Hotel
Sunday 31 January 2010	
9.30	Sodium and potassium intake of *Cercopithecinae* *W. Arnhold, M. Anke, K. Eulenberger*
9.45	Urolithiasis in maned wolves (*Chrysocyon brachyurus*) *R.J. Zwart, J. Nijboer*
10.00	Evaluation of a nutraceutical joint supplement in camels (*Camelus spp.*) *E.S. Dierenfeld, D. Baum, L. Hampe, J. Jenson, K. Wedekind*
10.15	A comparison of two different diets for growing Moon Jellyfish (*Aurelia aurita*) in Rotterdam Zoo *M. Biesheuvel, R. Jaeger, M. Laterveer, P. Niemantsverdriet, D. Kuiper, H. Kuipers, J. Nijboer, T. Huisman*
10.30	Species-dependent mineral accumulation in corals *G. Ludevese, D. Petersen, G.P.J. Janssens*
10.45	BREAK (30 mins) for Commercial & Poster Sessions
11.15	Hand-rearing a crowned sifaka (*Propithecus coronatus*): milk formulation, infant growth, comparison with mother-reared animals and previous protocols used in *Propithecus* *S. Laidebeure, A. Lecu, B. Quintard, D. Gomis, P. Moisson*
11.30	A novel diet to feed giant anteaters (*Myrmecophaga tridactyla*); research, design, development and trialing of Termant. *J. Moody, A. Warmington*
11.45	Feeding and body mass development in giant anteaters (*Myrmecophaga tridactyla*) *M. Clauss, M. Stahl, C. Osmann, S. Ortmann, J.-M. Hatt*
12.00	Concluding Remarks & Thanks

Poster Presentations

- Tropical forages in diets for endemic herbivorous ungulates in Costa Rica
  A. Brenes Soto
- Implementation of a new weakly allergenic regime for Callitrichids and other new world monkeys; preventive and curative effects concerning the Wasting Marmoset Syndrome and digestive sensibility
  M. Byrne
- Nutrient composition tables for fruits and vegetables as a decision tool for zoo animal keepers
  M. Clauss, J, Hummel, J.-M. Hatt
- Weight reduction in spectacled bears (*Tremarctos ornatus*)
  M. Clauss, R. Zingg, N. Ruckstuhl, S. Jutz, J.-M. Hatt
- Local food, global nutrient data - how do published values compare for commonly used diet ingredients?
  A.L. Fidgett, S.J.Forster
- Use of INFIC nomenclature on the feedstuffs in the National Zoological Gardens of South Africa
  U.K. Mwimbi, F.K. Siebrits, K. Mbatha
- Growth performance of larvae and postmetamorphic juveniles of the hynobiid salamander (*Pachyhynobius shangchengensis*)
  F. Pasmans, A. Martel, G.P.J. Janssens
- Diet of Kodiak bears *(Ursus arctos middendorffi*) compared; what is a good diet?
  J. Polet, T. Weber, T. Huisman, D. Kuiper, C. Berndt
- Study of the response to levels of difficulty in obtaining food for predatory birds in rehabilitation centers for wild animals
  H. Raposeira, P. Horta, A. Luís
- A multi-zoo survey of colobus monkey (*Colobus* sp.) feeding practice, diet composition and captive activity patterns
  P. Rose, L. Philips-Major
- Using an on-site browse plantation to ensure forage feeding to browsing herbivores at Woburn Safari Park
  J. Veasey
- Seasonal diets for brown bears *(Ursus arctos*) at Brookfield Zoo—successful implementation led to reduced weight and improved behaviour
  J.C. Watt

Giant steps forward

THE RESEARCH, DESIGN, DEVELOPMENT AND TRIALLING OF TERMANT HAS RESULTED IN A NOVEL DIET FOR THE FEEDING OF GIANT ANTEATERS

Jackie Moody, Assistant Registrar & Nutritional Coordinator, Marwell Wildlife; Allula Warmington, Senior Nutritionist, Mazuri Zoo Foods; Heidi Mitchell, Research Programme Manager, Marwell Wildlife

The giant anteater (*Myrmecophaga tridactyla*) displays a highly specialised feeding ecology that is challenging to support in captive environments. This has potential implications for the health and welfare of these animals in zoos. Marwell Wildlife and Mazuri Zoo Foods have collaborated in the design of a new diet that may better cater for the nutritional requirements of captive giant anteaters than traditional diets. Termant is commercially available and has been shown to afford improved hygiene, a reduction in the bacterial load supported by the diet, and quicker feed preparation times.

The giant anteater is native to Central and South America and exhibits a strategy of obligate myrmecophagy, meaning that this species survives on a diet composed entirely of ants and termites. Feeding ecology based on this strategy necessitates visiting up to 200 nests of various species of ant and termite per day. Replication of such a diet in captivity is largely unachievable because the quantities of ants or termites required to sustain anteaters are simply not available and there is no commercially available insect substitute. It is crucial therefore to find suitable ways to address the nutritional needs of captive giant anteaters. Little empirical evidence exists, however, to inform zoos about how best to achieve this.

A review of anteater diets in collections holding giant anteaters as of 2007, as listed on ISIS (International Species Information System) was undertaken by Marwell Wildlife. Analysis of nutritional components of captive giant anteater diets was carried out using zoo nutrition software. The basis of many of the reviewed captive diets included a type of dry dog or cat diet, raw meat, eggs and other dairy products. In order to cater for the specialised anatomy of anteaters, which includes a long tongue, very small mouth and absence of teeth, these ingredients tend to be blended together with water, and presented as a pap, soupy mixture or gruel. Crucially however, a number of previous studies have identified probable health issues associated with these gruel-type formulations. Chronic loose stools which are pasty and liquid in consistency are common in captive anteaters, and differ from the well-formed and firm faeces seen in free-ranging individuals. Vitamin K deficiency, constipation due to lack of dietary fibre, salmonella and sensitivity to bacterial cultures as a result of contaminated food products, tongue tip constrictions, and the potential for lactose intolerance have also been reported. Taken together, these observations indicate that diets fed to anteaters in zoos may be problematic and may compromise the captive health and welfare of these highly specialised animals.

NEW TYPE OF MEAL

In order to address the issues associated with captive anteater nutrition, Marwell Wildlife and Mazuri Zoo Foods aimed to develop a diet that supports the nutritional requirements of captive anteaters, takes account of the animals physiology by being easily manipulated and consumed, improves hygiene and reduces the potential for microbial load of the food, and facilitates easy food preparation by staff.

While there has been some systematic evaluation of wild giant anteater diets, there remains a gap in knowledge about appropriate nutrient composition of a captive diet, which must take account of issues such as risk of obesity. Current best practice assumes baseline nutritional requirements for captive giant anteaters, as well as aardvarks (*Orycteropus afer*), reflect that of strict carnivores such as felids although there is some debate about whether a canine rather than feline model offers a more appropriate baseline. Nevertheless, a requirement for taurine and arachidonic acid is assumed. When designing the new diet, Marwell Wildlife and Mazuri Foods therefore used a range of dog, cat, fox and mink National Research Council (NRC) requirements as a guide.

Termant has been formulated as a nutritionally 'complete' diet that is supplied in the form of a powder. This powder can be fed dry or mixed with water to achieve a gruel of desired consistency, thus allowing zoos to take account of anteaters' specialised feeding physiology, while still affording some flexibility to help collections cater for the preferences of anteaters.

Bacteriology testing on both the original Marwell diet and Termant diet indicated that a lower bacterial load is supported by the Termant diet. This could be important in reducing pathogen transfer which may occur

	Termant Nutrients (%) (10% H2O Basis)	Range of NRC Requirements (%)
Crude oil	10.17	5 – 9
Crude protein	28.33	22 – 30
Arachidonic acid	0.05	0.02 – 0.05
Taurine	0.19	0.17
Calcium	1.44	0.5 – 1.10
Total phosphorus	1.08	0.40 – 0.90

Nutritional components of Termant as compared to NRC ranges for nutrient requirements of dog, cat, fox and mink diets

via oral ingestion of contaminated feed by the animal. Additionally, Termant removes the need for raw meat and dairy products to be included in the captive diet of giant anteaters making it more hygienic to prepare by eliminating the need for keepers to handle these potentially higher risk foods (such foods are more susceptible to salmonella and other pathogens).

Termant is quicker and easier to prepare than more traditional diets resulting in greatly reduced feed preparation time. This frees up keeper time which can be maximised for other tasks essential to managing such specialised animals, such as carrying out behavioural monitoring or developing and managing an environmental enrichment programme.

The first batch of 'Termant' was made available to Marwell on 6th June 2008 and transition from the traditional diet to Termant was carefully managed for two adult male giant anteaters. The process took approximately 10 weeks and involved a gradual substitution of the traditional diet with Termant in increments of 5%, 10%, 25%, 50%, 75% and 100%. Following two incidences of loss of appetite, the quantities of Termant were reduced and the original diet was temporarily reinstated, after which incremental reintroduction of Termant began again. At the time of writing, Marwell's two male anteaters have been receiving Termant as a complete diet for approximately two and a half years. Body weights were monitored throughout the dietary change to ensure that any fluctuations could be identified and the appropriate alterations to the diet or transitional approach made. Pleasingly however, both individuals maintained consistent body weights throughout the transition period, and over the subsequent two years.

EASIER TRAVEL

Interestingly, the recent move of a male anteater from Marwell Wildlife to Lisbon Zoo in Portugal has highlighted an additional benefit of using a simple, nutritionally complete and standardised diet. The transfer of animals between zoological collections for breeding or exhibition purposes can be challenging to both the animal and the keepers at the new location. Animal stress associated with inter-zoo transfers can lead to both short- and long-term difficulties such as loss of appetite or a reduction in reproductive success. For keepers the task of sourcing dietary components that may have previously been included in the individual's food can make accommodating a new animal even more time-consuming and draw resources away from other tasks that may be important in helping the animal settle in. In this particular case, both Marwell and Lisbon use Termant to feed their anteaters and hence the animal being moved did not have to undergo any dietary transition, limiting the degree of change associated with the move. In addition to the potential animal related benefits, the keepers did not need to spend resources continuing with or phasing out particular dietary habits from the previous zoo.

To date, 18 zoological collections within Europe are currently either trialling or fully utilising Termant for their giant anteaters or similar insectivorous species, for instance aardvarks, aardwolves (*Proteles cristata*) and tamanduas (*Tamandua* spp). Future research to determine whether Termant influences captive behaviour, health and welfare, or reproductive measures of these highly specialised animals in the longer term is essential.

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Jonathan Cracknell, former Zoological Director, Marwell Wildlife
Andy Beer, Senior Practitioner in Animal Management, Sparsholt College Hampshire
South Section keepers at Marwell Wildlife

Iep (Ruwe)

Ulmus glabra

Engels
Wych elm

Duits
Bergulme

Bijzonderheden:
Wordt goed opgenomen.

Samenstelling:

Nutrient:	ds (%)	RA (%ds)	RE (%ds)	RV (%ds)	RC (%ds)	NDF (%ds)	ADF (%ds)	Ca (g/kg ds)	P (g/kg ds)
Blad		10	21	3	15	45	25	1,9	0,2

41

Meidoorn (Tweestijlige)

Crataegus laevigata

Engels
Mayflower

Duits
Zweigriffelige Weißdorn

Bijzonderheden:
In het wild zijn de bessen van de meidoorn een belangrijke voedingsbron voor veel dieren variërend van de bruine beer tot vleermuizen.

Beschrijving
Lengte blad: 2 tot 6 cm
Breedte blad: 2 tot 5 cm

Bladeren hebben dubbel getande randen, liggen verspreid en hebben 2 tot 3 licht ingesneden lobben

Samenstelling: onbekend

Nutrient:	ds (%)	RA (%ds)

46

Paardenkastanje (Witte)

Aesculus hippocastanum

Bijzonderheden:
De zaden van de witte paardenkastanje zijn giftig: ze bevatten een glycoside, aesculine. Daarom is het van belang om de noten (kastanjes) buiten bereik van dieren te houden.

47

dingsmiddelen besproeid. Daarom is het goed om na te gaan
de rozen vandaan komen. Gedroogd blad wordt wel graag gege

Beschrijving
Het blad van de roos bestaat uit een aantal kleinere blaadjes die aan een centrale stekelige stengel zijn bevestigd

Bladeren zijn ovaal en lancet-vormig

Rozen variëren in lengte en breedte

Samenstelling:

Nutrient:	ds (%)	RA (%ds)	RE (%ds)	RV (%ds)	RC (%ds)	NDF (%ds)	ADF (%ds)	Ca (g/kg ds)	P (g/kg ds)
Blad	26		18			32	18		

50

Zomereik

Quercus robur

Engels
English oak

Duits
Stieleiche

Bijzonderheden:
In de eikels zit veel tannine en kan bij grote inname dodelijk zijn. Ook in het jonge blad zit een vrij hoge dosis tannine. Er kan honingdauw op het blad zitten. Deze plakkerige vloeistof kan sommige schimmels aantrekken.

Beschrijving
Lengte blad: 7 – 14 cm

Blad heeft 3 – 7 diepe bochtige insnijdingen en heeft een asymmetrische vorm

Bladeren verspreid en zijn onregelmatig gelobd

Samenstelling:

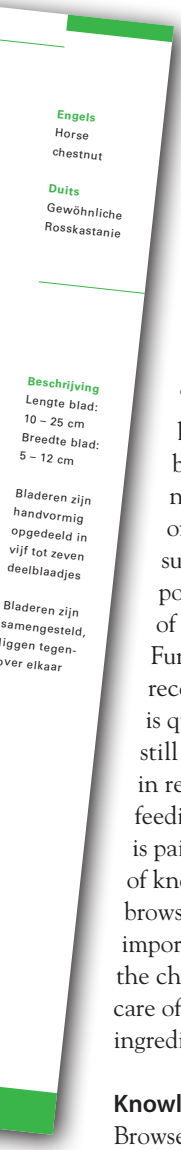
Nutrient:	ds (%)	RA (%ds)	RE (%ds)	RV (%ds)	RC (%ds)	NDF (%ds)	ADF (%ds)	Ca (g/kg ds)	P (g/kg ds)
Blad		6	17	4	26			8,8	2,7

60

Knowing what they eat

A NEW BOOK HAS BEEN PUT TOGETHER FOR ZOO KEEPERS TO HELP THEM BETTER IDENTIFY AND USE BROWSE

Tjalling Huisman, University of Applied Sciences Van Hall Larenstein, Dept Of Animal Management, Leeuwarden, The Netherlands; Joeke Nijboer, Blijdorp Zoo, Rotterdam, The Netherlands



The importance of browse as part of the diet of many zoo species and as a helpful tool for environmental enrichment is now regularly described in zoo nutrition publications. Yet browse remains a relatively unusual feed item compared to more 'traditional' product like hay, produce, fruit and pelleted feeds. There are few people who have knowledge of what is suitable browse. Many zoo workers are not aware of the feeding value of browse, which browse is suitable for which species, and the potential unwanted side effects of feeding the wrong browse. Furthermore most people cannot recognise most browse species. This is quite understandable since it is still a relatively new feed item and in regular courses on nutrition and feeding not much, if any, attention is paid to this type of feed. This lack of knowledge about the properties of browse results in the underuse of this important feed item. When they have the choice, people responsible for the care of animals will choose well-known ingredients.

Knowledge on browse increases use

Browse use will increase when more people involved in zoo animal care have more knowledge on the properties of browse and its possibilities and also become better trained in recognising browse.

The Dutch Zookeepers Federation (De Harpij) occasionally produces booklets on subjects of interest to zoo keepers, such as environmental enrichment. The Zookeepers Federation approached the authors with the request to develop a book on browse use and determination with contents adapted to the target group, zoo keepers. This assignment offered the opportunity to spread and improve general knowledge on browse properties and use.

It was agreed to produce a book of approximately 100 pages. The core part of the book should consist of pictures and descriptions of browse species and additional information on feeding value. On the same pages the scientific as well as the English and German vernacular names should be given. In addition to pictures, the book should also contain information on general aspects of browse use, toxicity of browse, conserving browse and a glossary.

Browse pictures

Information from several past surveys on browse use in Dutch zoos was used to make a list of browse species for inclusion in the book. Combining the outcomes of several surveys resulted in a list with 42 species including related species like sow thistle (*Sonchus oleraceus*), common nettle (*Urtica dioica*) and alfalfa (*Medicago sativa*). Initially it was planned to collect photos taken by students tackling project work but the results were rather disappointing.

To obtain good illustrations two large illustrated botanical works were used. The pictures taken from the books were digitally captured and since the books were printed more than 100 years ago, there were no copyright issues. The combination of picture source and digital adaptation resulted in very clear and attractive pictures.

Informative texts

The book starts with a chapter on the use of browse with information on which steps to take when feeding browse, as well as guidelines on the amounts to use. The chapter also gives a list of animal species for which browse is an important feed item. Another chapter focuses on secondary plant components and how to avoid the risks when using browse. Further chapters tackle browse quality, browse conservation and the use of browse as enrichment. The final section of the book contains a glossary with explanations of specific browse terms and general nutrition terms. There is also a list of useful books and other publications for further reading, and websites.

Further developments

During the development of the book it again became clear that there is comparatively little known about the properties of browse. Reliable data on the nutritional composition of browse species are scarce and often based on a very small sample size. Another difficulty is that experiences with browse use are not systematically collected, let alone published. Although some initiatives have been started to improve this situation, progress in this matter is still slow. The initiative of the Dutch Zoo Keepers Federation to produce this publication is a good example of how such a body can contribute to the dissemination of nutritional knowledge. The authors hope that other keeper organisations follow their example.

The next initiative is the translation of the booklet into English to make it available to a wider audience. The intention is to publish it before the EAZA Annual Conference in Montpellier in September 2011 but it will certainly be available at the 7th European Zoo Nutrition Conference in Zurich in January 2012.

Acknowledgments

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Greengrocery guide

NUTRIENT COMPOSITION TABLES FOR FRUITS AND VEGETABLES AS A DECISION TOOL FOR ZOO ANIMAL KEEPERS

Marcus Clauss and Jean-Michel Hatt, Clinic for Zoo Animals, University of Zurich; Jürgen Hummel, Institute of Animal Science, University of Bonn

FRUITS

	WATER	REST	PROTEIN	AVAILABLE CARBOHYDRATES	CALCIUM	PHOSPHORUS
		DRY MATTER	%		‰	
	%	%	---------- DRY MATTER ----------			
Honey	18.6	81.4	0.5	92.3	0.1	0.2
Rock melon	87.0	13.0	6.9	92.5*	0.5	1.6
Water melon	93.2	6.8	8.8	90.5*	1.5	1.6
Pineapple	85.3	14.7	3.1	89.3	1.1	0.6
Grapes	81.1	18.9	3.6	85.2	1.0	1.1
Apple	85.3	14.7	2.3	84.3	0.5	0.8
Dried dates	20.2	79.8	2.3	83.1	0.8	0.7
Cherry	82.8	17.2	5.2	82.6	1.0	1.2
Banana	73.9	26.1	4.4	82.0	0.3	1.1
Grapefruit	89.0	11.0	5.5	81.4	1.6	1.5
Pear	84.3	15.7	3.0	80.6	0.6	1.0
Peach	87.5	12.5	6.1	75.5	0.6	1.8
Mango	82.0	18.0	3.3	71.1	0.7	0.7
Plum	83.7	16.3	3.7	70.0	0.9	1.1
Apricot	85.3	14.7	6.1	67.6	1.1	1.4
Gooseberry	87.3	12.7	6.3	66.9	2.3	2.4
Kiwi	83.8	16.2	6.2	66.5	2.3	1.9
Fig	80.2	19.8	6.6	65.2	2.7	1.6
Orange	85.7	14.3	7.0	64.3	2.9	1.6
Strawberry	89.5	10.5	7.8	61.4	2.5	2.8
Blackcurrant	81.3	18.7	6.8	53.3	2.5	2.1
Redcurrant	84.7	15.3	7.4	48.6	1.9	1.8
Blueberry	84.6	15.4	3.9	47.8	0.6	0.8
Blackberry	84.7	15.3	7.8	46.7	2.9	2.0
Raspberry	84.5	15.5	8.4	44.6	2.6	2.8
Guava	83.5	16.5	5.5	40.6	1.0	1.9
Papaya	87.9	12.1	4.3	19.8	1.7	1.4
Avocado	68.0	32.0	5.9	1.3 (due to high fat content)	0.3	1.2

*minimum

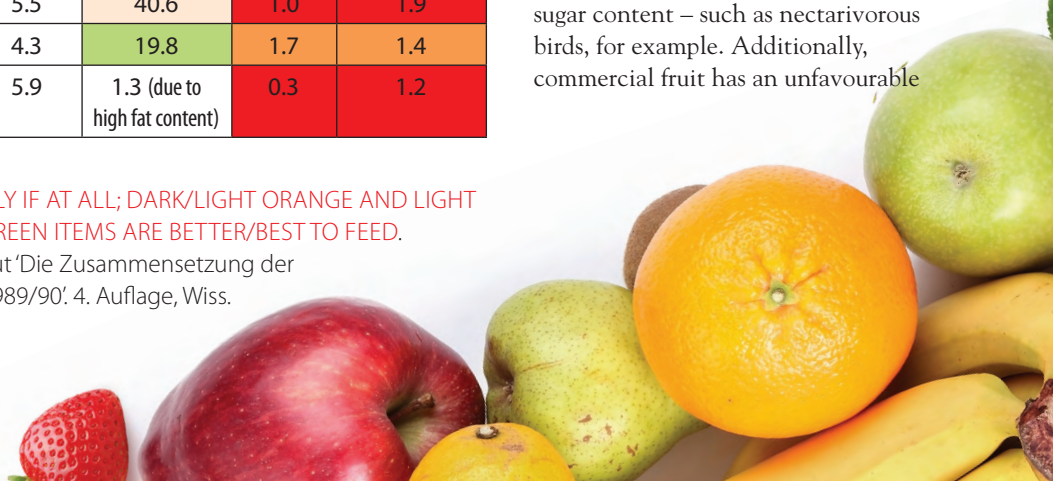
RED ITEMS SHOULD BE USED RARELY IF AT ALL; DARK/LIGHT ORANGE AND LIGHT GREEN ITEMS ARE OK AND DARK GREEN ITEMS ARE BETTER/BEST TO FEED.

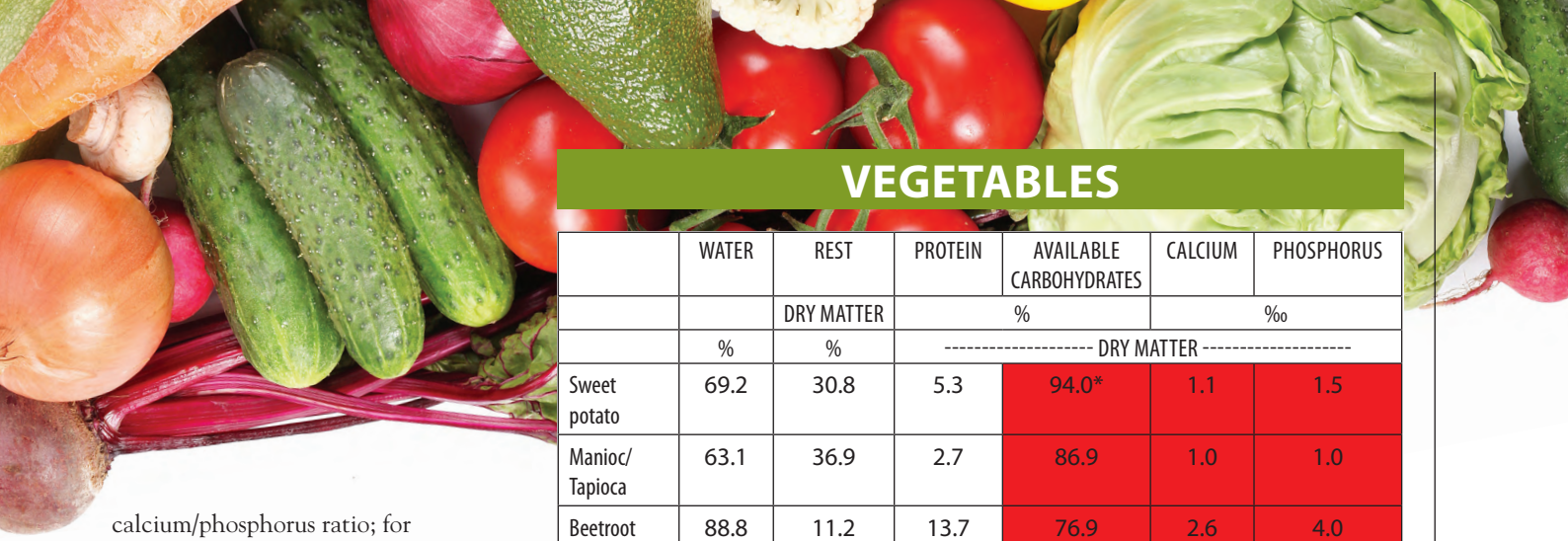
NOTE: Source: Souci/Fachmann/Kraut 'Die Zusammensetzung der Lebensmittel – Nährwert-Tabellen 1989/90'. 4. Auflage, Wiss. Verlagsgesellschaft Stuttgart

In human nutrition, fruits and vegetables are usually considered to be particularly healthy diet ingredients. Therefore, feeding such items to zoo animals is often regarded as proof for a particularly engaged, attentive feeding regime. However, in zoo literature, the feeding of such commercial fruits (cultivated to please the human palate) to herbivores, omnivores and especially primates has been discouraged for a long time.

To understand this discrepancy, we have to remember that, for humans, fruit is usually better than other snack alternatives such as chocolate bars or biscuits. If humans wanted to live particularly healthy, they would eat green leafy vegetables rather than fruits as snacks – but we know intuitively that such recommendations would meet with little enthusiasm.

In the wild, there is nothing that resembles the nutrient composition of commercial fruits. Those 'fruits' that frugivores eat in their natural habitat have a completely different nutrient composition from commercial fruits (Schwitzer et al 2009). This is due to the fact that commercial fruit contains high concentrations of sugar – this is why we like to eat them. 'Wild fruits' contain much less sugar, and more fibre. If we want to mimic their nutrient composition, we need to feed green leafy vegetables, not commercial fruit. Commercial fruits are only adequate for species that are adapted to a natural diet of high sugar content – such as nectarivorous birds, for example. Additionally, commercial fruit has an unfavourable





calcium/phosphorus ratio; for example, primates fed predominantly on commercial fruit are prone to metabolic bone disease. Note that, in the tables shown here, no commercial fruit is adequate in terms of its calcium/phosphorus ratio.

Many frugivorous animals show adaptations to high-fibre diets. They simply will not ingest fibre in a form we are most used to – as hay or typical 'roughages'. Green leafy vegetables should be better in this respect. Unfortunately, in practice, animals sometimes do not tolerate a change from commercial fruits to green leafy vegetables easily, and thus make the respective diet changes doubtful for all personnel involved. In an attempt to make diet changes part of everyone's routine thinking, we collated literature data on the protein, non-fibre carbohydrate, calcium and phosphorus content of fruits and vegetables, using a colour coding system to indicate adequacy of items. The objective is that each zoo keeper should assess the diets usually fed to the animal in their care, and think about, or try out, the acceptance of potentially more adequate items before an official diet change is formulated. In doing this, we hope to stimulate active participation of all involved in zoo animal care in suggesting feasible diet changes.

VEGETABLES

	WATER	REST	PROTEIN	AVAILABLE CARBOHYDRATES	CALCIUM	PHOSPHORUS
		DRY MATTER	%		‰	
	%	%	---------- DRY MATTER ----------			
Sweet potato	69.2	30.8	5.3	94.0*	1.1	1.5
Manioc/ Tapioca	63.1	36.9	2.7	86.9	1.0	1.0
Beetroot	88.8	11.2	13.7	76.9	2.6	4.0
Potato raw/ cooked	77.8	22.2	9.2	69.4	0.4	2.3
Cucumber	96.8	3.2	18.8	64.7	4.7	7.2
Tomato	94.2	5.8	16.4	59.5	2.4	4.5
Pumpkin	91.3	8.7	12.6	54.9	2.5	5.1
Green beans	90.3	9.7	24.6	54.5	5.9	3.9
Onion	87.6	12.4	10.1	46.7	2.5	3.4
Kohlrabi	91.6	8.4	23.1	45.8	8.1	5.9
Carrot	88.2	11.8	8.3	41.8	3.5	3.0
Chicoree	94.4	5.6	23.2	41.4	4.6	4.6
Squash	88.7	11.3	12.4	40.6	2.4	3.8
Radish	94.4	5.6	18.8	39.6	6.1	4.7
Aubergine	92.6	7.4	16.8	35.9	1.8	2.9
Sweet pepper	91.0	9.0	13.0	35.7	1.2	3.2
Celery stalks	92.9	7.1	16.9	30.7	11.3	6.8
Cauliflower	91.6	8.4	29.3	30.2	2.4	6.4
Chinese cabbage	95.4	4.6	25.9	29.1	8.7	6.5
Leek	89.0	11.0	20.4	29.0	7.9	4.2
Broccoli	89.7	10.3	32.0	27.4	10.2	8.0
Zucchini	92.2	7.8	20.5	25.6	3.8	2.9
Brussels sprouts	85.0	15.0	29.7	25.1	2.1	5.6
Savoy cabbage	90.0	10.0	29.5	24.1	4.7	5.6
Lettuce	95.0	5.0	25.0	22.0	7.4	6.6
Kale/Green cabbage	86.3	13.7	31.4	21.7	15.5	6.4
Fennel	86.0	14.0	17.4	20.1	7.8	3.6
Celery root	88.6	11.4	13.6	19.7	6.0	7.0
Girasole	78.9	21.1	11.6	19.0	0.5	3.7
Artichoke	82.5	17.5	13.7	16.6	3.0	7.4
Field salad/ Lamb's lettuce	93.4	6.6	27.9	10.6	5.3	7.4
Mangold	92.2	7.8	27.3	8.8	12.8	5.0
Spinach	91.6	8.4	30.0	7.3	15.0	6.5
Parsley	81.9	18.1	24.5	7.2	13.5	7.1
Endive	94.3	5.7	30.7	5.3	9.5	9.5

Sugaring the message

TACKLING NUTRITION ASSOCIATED STILLBIRTHS IN GOLDEN-HEADED LION TAMARINS

Anouk Fens, Wageningen University; M. Fermaat and Tjalling Huisman, University of Applied Science Van Hall Larenstein

In early 2010, Antwerp Zoo was thrilled by the birth of two endangered golden-headed lion tamarins. Part of the reason for this joy was that in some European zoos, including Antwerp, the breeding of these tamarins is often characterised by a high percentage of stillbirths.

A diet evaluation study has been carried out in order to investigate the relationship between inappropriate feeding and stillbirth. Zoos that have experienced problems with stillbirths were feeding the tamarins a diet relatively high in sugar content, caused by the proportion of fruit included. Although the diet of wild golden-headed lion tamarins consists mainly of fruit, sugar compositions of fruit consumed in the wild are much lower compared to sugar levels in the cultivated fruit we feed our zoo animals. Consuming a high sugar level increases the risk of developing gestation diabetes and foetal macrosomia, which in humans may lead to macrosomia and stillbirth mortality.

Golden-headed lion tamarins (*Leontopithecus chrysomelas*) are small, diurnal South American primates that taxonomically belong to the family *Callitrichidae*. They are Endangered in the wild, with population declines estimated to be over 50% in the last 21 years. Since 1999, the breeding of golden-headed lion tamarins in Antwerp Zoo has resulted seven out of ten newborns being stillborn. Necropsies have revealed dystocia (difficult delivery) caused by foetal macrosomia (disproportionately large young) as the main cause of this high mortality. The stillborn young had an average body weight of 83g, which is high compared to the average body weight of healthy new-borns in the wild (50 g) (Napier & Napier, 1985; Ross, 1991).

To determine the nutritional intake of the tamarins, the current diet fed in Antwerp Zoo was evaluated and the nutrient profile on a dry matter basis compared to nutritional requirements for *Callitrichidae* provided by the National Research Council (2003). However, no requirements were

TABLE 1: Nutritional composition in % DM of the diets fed the eight European zoos. Four zoos were excluded because the lack of a breeding pair during the study period.

	'stillbirth zoos'				'non-stillbirth zoos'			
Nutrient	1	2	3	4	5	6	7	8
ME (MJ)	1.2	2.0	1.4	1.65	2.0	1.6	1.6	2.0
CP (g)	15.6	20.4	12.9*	29.2	31.2	21.5	22.7	29.4
NDF (g)	8.0	9.6	11.4	7.2	2.2	10.3	10.6	7.1
ADF (g)	3.1	6.0	8.6	3.3	1.2	4.6	4.2	4.4
Total sugar (g)	16.8	43.4	34.9	30.5	31.8	16.6	19.7	27.5
Glucose (g)	4.9	12.4	5.8	8.2	3.2	5.2	5.0	9.0
Fructose (g)	7.8	14.5	8.8	10.2	5.3	6.0	7.8	12.6
Sucrose (g)	4.0	10.1	5.1	3.5	2.8	4.3	6.6	5.3
Ca (g)	3.6	3.1	0.7	0.7	0.5	1.1	1.6	0.8
P (g)	2.9	2.9	0.3	0.5	0.5	0.7	0.8	0.5

* Data provided was incomplete, thus value is the minimum calculated

MARCEL BURKHARD

TABLE 2: Average sugar composition in % DM of the diet fed in 'stillbirth zoos' and 'non-stillbirth zoos' and the sugar composition of wild fruit in % DM, obtained from Schwitzer et al, 2003.			
Nutrient	'stillbirth zoos' (N=4)	'non-stillbirth zoo' (N=4*)	Wild fruit
Glucose	7.7	5.6	1.2
Fructose	10.4	7.9	1.0
Sucrose	6.4	4.8	0.1
** Four out of eight 'non-stillbirth zoos' were not taken into account, because those zoos did not have a breeding couple/no offspring in the last five years.			

found for glucose, fructose and sucrose, therefore the sugar contents of fruit consumed by tamarins in the wild was used as an indication (obtained from Schwitzer et al, 2009).

To get an insight into diets fed in European zoos in relation to stillbirth mortality, a survey was sent to all European zoos that currently keep golden-headed lion tamarins in their collection. A distinction was made between zoos with the same reproductive problems as Antwerp Zoo, so-called 'stillbirth zoos', and zoos which did not have any stillbirth related problems, the so-called 'non-stillbirth zoos'.

It was determined whether the diets fed in those groups of zoos varied in nutrient composition, and whether any differences might be linked to nutritional factors contributing to macrosomia and stillbirth mortality. The survey requested 'general information' (number of species held, sex ratio, housing) 'diet' (design, supplementation), and 'stillbirth' (reproduction problems, body weight of dead young). Almost half of 44 zoos returned their survey (19 in total: 7 'stillbirth zoos'; 12 'non-stillbirth zoos'). Data from returned diet sheets were used to calculate the dietary values and nutrient compositions of all diets obtained compared with the nutrient requirements for *Callitrichidae*.

Within the 12 zoos that were analysed, large differences were found between food items. In total, 86 different ingredients were fed, with only apple and banana common to all. All zoos added supplements to their diet, and seven different commercial primate foods were used, along with some uncommon products, such as parsnip, coconut, nectar, cheese and yeast.

After comparing the nutrient values of the diets fed in 'stillbirth zoos' to those fed in 'non-stillbirth zoos' and to the composition of fruit in the wild, no large differences were found, except for the sugar levels (Table 1).

In both Antwerp Zoo and the other 'stillbirth zoos', the sugar levels fed were higher. However, sugar levels of both 'stillbirth' and 'non-stillbirth zoos' are elevated when compared to sugar compositions of wild fruit, with slightly higher levels found in the 'stillbirth zoos' (Table 2).

The higher dietary sugar levels in 'stillbirth zoos' compared to 'non-stillbirth zoos' were caused by a higher proportion of fruit in the diet. In general, the higher sugar levels fed in captivity are a consequence of wild fruit containing lower sugar levels compared to cultivated fruit (see Table 3).

It is known that that foetal macrosomia in humans, which may have contributed to the dystocia and stillbirths recorded for the tamarins, may be caused by gestation diabetes and maternal obesity. Dietary sugar influences glucose homeostasis so consuming high sugar levels increases the risk of developing (gestation) diabetes and obesity, which both may possibly lead to macrosomia and stillbirth.

Except for Antwerp Zoo, most zoos did not weigh their animals on a regular basis and could not provide us with information on body weight, so no conclusions about obesity were drawn. It is recommended that all zoos start weighing their animals on a regular basis.

To prevent excessive birth weight in the future, lower dietary sugar levels can be achieved by removing fruit items gradually from the diet, and by avoiding other sugar-rich products. Furthermore, literature indicates that a diet high in fibre significantly improves blood glucose control compared to a low-fibre diet. Adding products rich in soluble fibres, such as gum Arabic or beet pulp, may be a good addition to the diets of 'stillbirth zoos'. Both dietary changes might have a positive effect on controlling blood glucose levels and therefore reducing the incidence of macrosomia and stillbirth in the tamarins.

The value of nutrition surveys are often underestimated. However, as in this case, nutrition surveys can be a powerful tool in evaluating and optimising nutrition of zoo animals and, therefore, can be of great importance for European breeding programmes.

TABLE 3: Sugar composition of wild fruits and cultivated fruits (mean in % DM ±sd) (Schwitzer et al., 2009)		
Nutrient	Wild fruits	Cultivated fruits
Fructose	1.03 ± 1.19	17.74 ± 11.04
Sucrose	0.12 ± 0.14	16.03 ± 14.24
Glucose	1.15 ± 1.17	13.51± 8.86

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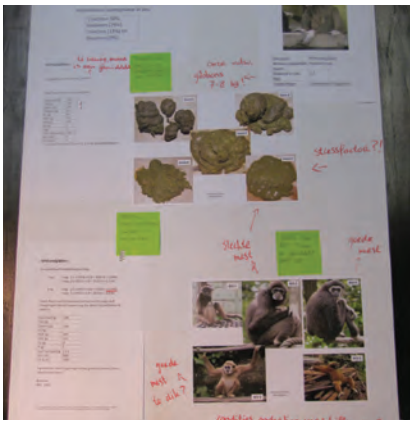

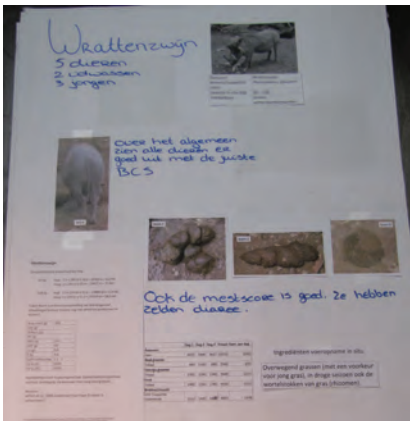

Course of action

A SPECIAL REPORT ON AN ANIMAL NUTRITION COURSE FOR ZOO KEEPERS

Tjallling Huisman and Jolanda Polet, University of Applied Science Van Hall Larenstein

A zoo animal nutrition course for Dutch zoo keepers and other zoo staff was organised in 2010. Three courses took place with a total of 50 participants and evaluations showed that the content met the expectations and requirements of the participants.

Why this course?

Over recent decades, knowledge on zoo animal nutrition has improved considerably. Results of large and small research projects and case studies were (and still are) disseminated through conferences in the US and Europe. Many studies have been published in scientific and other journals or specialised books like the 'Zoo animal nutrition' series. Participants of conferences and readers of scientific journals tend to be researchers, animal nutritionists, specialised zoo staff and zoo management. Zoo keepers, however, don't often attend conferences, and journals in which such results are published are not aimed at this specific group and rarely read by them.

Yet zoo keepers play a key role in zoo animal nutrition. In many cases they are the ones who prepare the feed, offer the feed to the animals and report on their experiences with the diet. They are the first to observe changes in animal health and behaviour as a result of the diet or a diet change. Therefore they are potentially an indispensible 'tool' for the assessment of diets and diet changes.

In 2005, 87 zoo keepers and 19 other staff (nutritionists, curators, veterinarians) from eight Dutch zoos were interviewed and/or asked to fill in a questionnaire on their knowledge of and attitude towards zoo animal nutrition. Among the remarkable results was the revelation that in formal education for future zoo keepers, little or no attention is paid to zoo animal nutrition as a course subject. There was a high percentage of 'false' ideas amongst the respondents, such as the necessity for fruit and for supplements and the existence of animal nutritional wisdom. Many respondents stated that they made occasional diet changes without further consultation. In general, respondents felt that there was not enough formal communication of nutrition practice between keepers and other staff.

Based on the results of this project and further experiences during case studies, it seems that communication might be the big issue for further advancement of zoo animal nutrition and the implementation of new discoveries. Keepers often do not fully believe the nutritional advice they get (from inside and outside), and have their own ideas. The experiences and knowledge of keepers seems to be an underused source.

How to improve nutrition communication

Adequate communication between all parties involved in zoo animal nutrition is a prerequisite for the successful implementation of new diets and for getting useful feedback after diet changes. A better understanding of the 'why' behind a diet or diet change increases the willingness to follow up proposals for diet change. Speaking the same nutritional language on all levels contributes significantly towards the exchange of information in and outside the organisation.

A dedicated course on zoo animal nutrition could contribute to improved communication. Van Hall Larenstein of the University of Applied Sciences started a project to design such a course in 2009. This project was carried out with the support of the nutrition group of the Dutch Zoo Federation (NVD) and the EAZA Nutrition Group

(ENG). The project was funded by an education innovation grant from the Dutch Ministry of Agriculture and by the participating education institutes.

Course content and design

The course is three days long in total, but spread over time so that between each course day there is a period of approximately one month. During the periods in between the participants are expected to carry out assignments aimed at one of the species they are (or feel) responsible for.

Subjects covered during course days included a general introduction on zoo animal nutrition as a specialised subject, the anatomy of the gastro-intestinal tract in relation to feed choice, composition of *in situ* diets and what can be learned from it for zoo diet assessment, and the pitfalls of supplementation. More general subjects were a series of lectures on nutrients and energy, the properties of dietary items, the role of UV-B, and safe working with animal products. Examples and case descriptions were always zoo animal-related.

A special course manual was developed with additional material, hints for information resources on zoo animal nutrition and an extensive glossary.

Course assignments

An important aspect of the course was a set of assignments aimed at species chosen by each course participant. The assignments were to be carried out in the two periods between the three course days. By encouraging assignments based around the participants 'own' animals, the course team aimed to achieve a better connection between the theory presented and daily practice.

The assignments were introduced with a presentation during a course day. Assignments were supported with a handout on which the steps to be taken were described and where 'best practice' examples were given. Participants were requested to hand in their work one week before the following course day. For this a special course email account and a website with file exchange abilities was available. The course team collected and edited the participants' work and this was presented on the next course day.

During the first course day three assignments were introduced: Body Condition Scoring (BCS), Scoring of Faeces, and Reading and Interpreting Feed Labels. For the body condition scoring assignment the participants were asked to develop a BCS scale for their animals with the help of photos taken or collected. The faecal scoring assignment took a similar form. For the label assignment, participants were asked to collect a label from a concentrate or similar product used for their animals. A set of questions was available to help participants understand and interpret label information.

The final assignment, presented on the second course day, required participants to measure feed and, if possible, feed leftovers for five to seven consecutive days. From this the average amount given or average intake per animal per day had to be calculated with the help of a specially developed spreadsheet. Two weeks before the last course day the results were sent to the course team and from this the amount of energy offered and a nutrient profile (average nutrient composition on dry matter basis) was calculated by them. All the material was edited and made available on the last course day together with the material from the previous assignments. Additionally, information on energy and nutrient requirements and wild diet ingredients was made available to the participants.

In the afternoon of the last course day the participants were asked to make a poster with the available material and their own comments added. These posters were presented and discussed with the lecturers and fellow participants.

Evaluation

Each of the three courses given in 2010 was evaluated by an extensive questionnaire. In total there were 50 participants of whom 38 filled in the questionnaires completely. Course participants were on average very satisfied with the course as a whole. On a 10-point scale, the reader, assignments, course location and catering scored on average a mark between 7.7 and 8. Points of criticism included the length of the course day, a perceived mammal bias in course content and lack of information on the nutrition of juvenile animals. The specially developed course website (www.dierentuinvoeding.nl) scored 6.7, probably due to the fact that the website was underused during the course.

Follow up

During the course lots of valuable material was collected from the participants, forming a resource for the development of further educational content like instruction posters and case descriptions, to be used for future courses. Financing the development and implementation of these types of courses is a difficult task, especially in the current economic climate. The course team, however, is convinced that a course like this contributes to the advancement of zoo animal nutrition. Therefore we hope to continue the initiative both nationally and (if possible) internationally.

Acknowledgments

The authors wish to thank the Dutch Zoo federation Nutrition Group and the ENG steering committee group of the ENG for their support, and also the following for their valuable contributions: Joeke Nijboer, Cora Berndt, Jan Bos, Martine Verheij, Marcus Clauss, Andrea Fidgett, Loes Spit, Siebren Kuperus, the course participants and many others.

Nutrition myths exposed!

'ANIMALS HAVE NUTRITIONAL WISDOM, DON'T THEY?' AND OTHER MISCONCEPTIONS...

EAZA Nutrition Group

There are many views about feeding zoo animals that are long established but incorrect; you might call them zoo nutrition myths. Although nutrition is an area of animal management which is increasingly better studied and documented, sometimes the lessons learned have not been available or summarised plainly enough for all to read and learn, and misinformation continues to be used every day. But with a little effort, false impressions can be corrected.

Members of the EAZA Nutrition Group were invited by email to submit false views, statements or mistakes they most commonly encountered. Zoo personnel working across Europe, North and South America, Africa & Australia came up with 100 suggestions. Below is a selection of the zoo nutrition myths, with explanations on why the views are incorrect from an expert panel of the EAZA Nutrition Group Steering Committee. While by no means a comprehensive list of common errors, it is a good starting point for improving zoo animal nutrition. It is hoped to make the full list (plus explanations) a feature of the EAZA Nutrition Group area of the EAZA website.

Animals have nutritional wisdom, don't they?
The innate ability of animals to always seek out deficient nutrients is a myth and, instead, animals (like us) consume what they like to eat. Nutritional wisdom has been suggested as a means by which animals obtain a nutritionally balanced diet. The theory proposes that animals have 'specific hungers' and can sense nutrients in the diet, thereby making selections for the elements required. Yet in free-ranging and captive animals few studies have demonstrated the ability to forage for particular nutrients, although appetites for sodium and calcium exist in several groups of species. Factors such as taste, texture, odour, size, shape, colour and even movement are all important facets in preferences and palatability, at times even more so than actual nutrient content. Just because foods are easily accepted and consumed, does not automatically mean they are nutritionally correct and appropriate. Specifically, foods that are high in sugar and fat are readily accepted but tend to have a poor nutritional balance overall.

Nonetheless, wild animals must make the right choices in their natural habitat. We even use wild diet information to estimate nutrient requirements. This might seem contradictory to the statements above, however dietary habits in the wild are a result of processes which we all know as 'evolution' and 'natural selection'. Animals which make the wrong dietary choices don't survive in the wild let alone pass on their genes. It is obvious that for various reasons these processes cannot be replicated in a zoo environment. It is our responsibility to be the wise ones.

An optimal diet consists entirely of natural foods, such as produce.
Unless and until zoos are able to replicate the complexity of diets encountered in the wild, animals will be faced with choices they haven't evolved to make. Most 'natural' foods used in zoo nutrition are cultivated for human tastes

and are nutritionally quite distinct from their wild counterparts. Although the physical form of food, dietary diversity and food presentation is vital for promoting normal feeding behaviour and physiology, specific nutrients are required, not necessary specific foods. We can rarely duplicate ingredients of any animals' diet in a captive situation. What we can duplicate are the nutrients contained within that diet, using nature as a basis for evaluating chemical composition and guiding dietary form and presentation.

Supermarket fruits are the perfect dietary substitute for wild fruits.
In the wild, frugivore animals eat reproductive parts of plants, termed 'fruits' in botanical science. Their nutrient composition largely deviates from commonly known fruits like apples, oranges and bananas. The natural diet contains amounts of fibre that by far exceed the level in commercial fruits. The combination of a high sugar and low fibre content in commercial fruits in comparison with wild fruits, makes them rich in energy. This increases the risk of developing obesity, especially since many captive animals cannot display the same activity level as in nature. Although the public often considers obese animals as cuddly, it makes the animals more prone to metabolic disorders, eg diabetes. Some vegetables might therefore better suit the dietary requirements of frugivores than commercial fruits. Contrary to popular belief, green leafy vegetables are as rich in vitamins as commonly used fruit items such as apples, although vegetables have lower sugar concentrations, and higher fibre content, which might better suit the dietary requirements of frugivores.

Nutritional software tells you whether diets are good or bad.
Software will calculate the nutrient composition of a diet for you, and maybe even compare it to requirement data so that you can judge whether the diet is meeting those requirements, or in excess, or in deficiency. However, the nature of such software always makes it necessary that someone with some background knowledge checks the source data, whether the results are plausible, and whether the requirement data is correctly chosen. Designing a diet does not begin or end with playing with a software program; you need to know what feeds you have available, what your animals will eat, what the feeding logistics are (ie you have to be able to tell if a diet is *realistic* – something the computer won't tell you). You will never get an absolute match of diet and requirement data, and you will have to be able to distinguish important from irrelevant discrepancies. A typical example would be a diet that is adequate in minerals and vitamins but contains unrealistic fat levels (for which no requirement data exist). Finally, a 'good' or 'balanced' diet is not only fundamental to animal welfare but, as with humans, it also is a key element in health and fertility. Thus, reproduction and absence of disease are more reliable indicators of successful nutrition. Knowledge and experience of working with a wide range of species-specific peculiarities are essential skills that cannot currently be incorporated in computer programs and must be present when using software tools.

EAZA Nutrition Group

www.eaza.net/activities/pages/nutrition.aspx

The EAZA Nutrition Group (ENG), reporting to the Research Committee, seeks to improve communication and coordination among all those engaged in research, education, or application of comparative (zoo) nutrition, and those requiring nutrition information, chiefly within zoological institutions of Europe. The mission statement of the ENG is:

'To promote and support nutrition in zoological institutions as an essential component of their conservation mission'

Membership is open to all individuals who support the aims of the EAZA Nutrition Group or need to know how they can improve nutrition in their zoo. Joining the group is simple; please e-mail Andrea Fidgett (a.fidgett@chesterzoo.org) putting 'Join ENG' in the subject line. Afterwards, you will receive a form asking for your contact details and also to indicate your interests and/or expertise.

From the Library on the website

EAZA Nutrition Group Newsletters
European Zoo Nutrition Conferences

International Symposium on Pet Bird Nutrition
To order contact: josef.kamphues@tiho-hannover.de

Zoo Animal Nutrition Books

These books gather together the scientific contributions to the European Zoo Nutrition Conferences. Abstracts for all of the articles in each book can be found on the EAZA website.

Zoo Animal Nutrition IV (2009)
Edited by M. Clauss, A. Fidgett, G. Janssens, J.-M. Hatt, T. Huisman, J. Hummel, J. Nijboer, A. Plowman. Filander Verlag, Fürth, ISBN-13: 978-3-930831-72-2

Zoo Animal Nutrition III (2006)
Edited by A. Fidgett, M. Clauss, K. Eulenberger, J.-M. Hatt, I. Hume, G. Janssens, J. Nijboer. Filander Verlag, Fürth, ISBN-10: 3-930831-57-0, ISBN-13: 978-3-930831-57-9

Zoo Animal Nutrition II (2003)
Edited by A. Fidgett, M. Clauss, U. Ganslоßer, J.-M. Hatt, J. Nijboer. Filander Verlag, Fürth, ISBN-10: 3-930831-51-1

Zoo Animal Nutrition I (2000)
Edited by J. Nijboer, J.-M. Hatt, W. Kaumanns, A. Beijnen, U. Ganslоßer (eds). Filander Verlag, Fürth ISBN-10: 3-930831-29-5

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7th European Zoo Nutrition Conference
University of Zurich, 27-30 January 2012

Workshop
27 Jan 0900-1700
Feeding herbivores: forage quality evaluation, roughage hygiene, and herbivore diet formulation and assessment

Conference

27 Jan 1800	Icebreaker
28 Jan 0900-1700	Scientific and practical sessions (incl. topics 1,2,3)
29 Jan 0900-1700	Practical sessions incl. demonstrations, Question/Answer session, 'Round table' poster sessions (incl. topic 4)
30 Jan 0900-1200	Scientific sessions (incl. topic 5)

Specific topics:
(1) Diet imprinting and diet changes
(2) Feeding of primates
(3) Feeding of amphibians
(4) Feeding of bears
(5) Feeding of elephants ... and free topics

Oral presentations (10 or 20 minutes, 5 minutes discussion)
Poster presentations
Q/A-sessions (for question/answer sessions, participants can send their questions to the organizers in advance in PowerPoint format including - if available - photos)
Podium discussions on the specific topics (and on free topics if several submissions are made that relate to each other)
Demonstrations (body condition and faecal scoring, food presentation, intake measurements, commissary organisation)
Submission deadlines
Oral presentation/poster abstracts: 30 September 2011
Questions for Q/A session: 31 December 2011
(email to mclauss@vetclinics.uzh.ch)

The conference, including dinners, will be held at the Irchel Campus of the University of Zurich, with ample space for interactions and networking.

Registration fees (Euros)*		
Type	until 30 Sept 2011	after 30 Sept 2011
Workshop	80	110
Workshop (student)	50	80
Conference	280	310
Conference (student)	250	280

**registration fees include*
- for the workshop: coffee breaks and a lunchbag
- for the conference: icebreaker, coffee breaks, lunchbags on all three days, diner on Saturday and Sunday, 4-day public transport ticket, abstract book

Hotel Reservation
We recommend to book rooms (share a double room) at the
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Heidi Abel Weg 5, 8050 Zürich
Tel: 044 307 47 00, Fax: 044 307 47 47,
Email: H2980@accor.com, Homepage: www.ibishotel.com
When booking a room, indicate you come for "European Zoo Nutrition"
Prices (per night, including breakfast)

26–27 Jan 2012	Double bedroom CHF 116.30
	Single bedroom CHF 103.30
27–30 Jan 2012	Double bedroom CHF 95.30
	Single bedroom CHF 82.30

Parking CHF 18.00 per night
The hotel is in walking distance to the conference site.

Check also regularly http://www.eaza.net/activities/Pages/NutritionConference.aspx for updates
Registration for the conference starts July 2011 through the website