Wildlife Nutrition

A Publication of Canada's Accredited Zoos and Aquariums
Nutrition Advisory and Research Group (CAZA-NARG)

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Photo Credits: National Geographic

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In This Issue . . .

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The Biology of Fun

A factor in the provision of appropriate nutrition to captive wild animals is the behaviours inherent in their wild feeding ecology as a species. In captivity, this is often referred to as "enrichment" as in environmental enrichment, occupation, or "something to do" to ensure that captive animals are challenged and – yes – entertained in their environment on a daily basis. Should "fun" be a consideration when we provide enrichment for captive animals? A recent issue of "Current Biology" provides some research to support the concept of fun in many species.

The January "Current Biology" (2015, 25(1): 1-130) is dedicated to the biology of fun in many species including amphibians, apes, birds, canines, dolphins, fish, invertebrates and reptiles. The issue also includes some excellent definitions of "fun" and "play". Authors in this edition include researchers with backgrounds in biology, ecology and zoology.

As professionals, we are continually searching for ways to improve the care we provide for our animals. The first issue in 2015 of "Current Biology" is one resource to start off your year of continued professional improvement.

Photo Credits: National Geographic

Nutritional Pathology and Diet of the Rock Hyrax

An extensive document on possible nutritional pathology in captive rock hyrax (*Procavia capnesis*) is now available on the CAZA-NARG website.

A review of 545 historic autopsy records (1912-2012) of Taxon Advisory Group (TAG) institutions holding rock hyrax by Deborah McWilliams and Yvonne Strode of the Peoria Zoo (Peoria, Illinois, U.S.A.; **vstrode@att.net**) was done to investigate the incidence of nutritional pathology in the species. Deborah McWilliams has a dual role as a nutrition advisor for the Rodent, Insectivore, Lagomorph Taxon Advisory Group (RIL-TAG) and for Canada's Accredited Zoos and Aquariums Nutrition Advisory and Research Group (CAZA-NARG). Yvonne has a dual role as Director of the Peoria Zoo and as the Rock Hyrax Species Manager.

The result of the autopsy review is an extensive document that is now posted on the CAZA-NARG website (www.caza-narg.ca) under "Resources". This document was first provided to those zoological institutions holding rock hyrax. Users of the material should understand that the data is limited to the autopsy findings and it is a retrospective study meaning the autopsy records included in the data can only viewed as having possible nutritive factors in the development of the pathology stated in each record.

Photo Credit: National Geographic

The extensive database of autopsies has produced some convincing evidence that the diets of captive rock hyrax are a factor in several disease processes. Indicators of nutritional pathology were found in 57.6% of the autopsy records. Nutritional pathology was most often an incidental finding and not always stated as the cause of death. However, in those records with indicators of nutritional pathology, there were usually concurrent nutritional pathologies. In order of prevalence, the nutritional pathologies include diabetes, iron storage disease (hemosiderosis and/or hemochromatosis), inflammation of the gastrointestinal tract (GIT), GIT obstruction and, various nutritional pathologies (vitamin E deficiency, selenium deficiency, zinc deficiency and malnutrition).

The document delineates the pathogenesis of some probable nutritional pathologies in rock hyrax and includes a review of the wild feeding ecology of the rock hyrax. The discussion of the nutritional pathologies in order of prevalence includes possible diet-related and environmental factors in the pathogenesis as relates to the wild feeding ecology of rock hyrax. The final section of the document includes a recommended diet for captive rock hyrax based on the wild feeding ecology of the rock hyrax and the nutrient requirement in form and function of the rock hyrax physiology

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*Antelope species, caribou (reindeer), deer, elk, giraffe, goat species (most, including ibex and mountain goats), moose, mountain sheep, musk oxen

CAZA Rodent Herbivore with Vitamin C: **Our Rodent herbivore with vitamin C is formulated based on the wild feeding ecology of herbivorous rodent species including beaver, capybara, porcupine and rock hyrax. It is a low-sugar, low-starch pellet that offers the appropriate types and ratios of fibre recommended for browsing ruminant species. This product must be fed with forage (hay or browse).**

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Deborah McWilliams is a wildlife nutritionist and founder of the Canada's Accredited Zoos and Aquariums Nutrition Advisory and Research Group (CAZA-NARG). She has 15 years of experience in wildlife nutrition and has worked with zoological institutions and wildlife parks and preserves internationally as a consultant, workshop presenter and educator in wildlife nutrition. In addition, Deborah is a nutrition advisor for the CAZA Herpetology Taxon Advisory Group (TAG) and for the Association of Zoos and Aquariums Rodent, Insectivore and Lagomorph TAG (AZA RIL-TAG). Deborah published the first edition of "Applied Zoo Animal Nutrition" in 2010 and this book is used by zoological institutions in eight countries.

Penguin Nutrition

The provision of food quality and variety to captive penguins is always a challenge for those zoological and wildlife institutions with penguin colonies. All penguin species eat similar diets, although some species have preferences for various prey depending on season, geographic location and prey availability.

Penguin species are piscivorous and are opportunistic foragers that prey upon cephalopods (e.g., cuttlefish, squid), crustaceans (e.g., amphipods, crab, krill, shrimp), fish (e.g., anchovy, herring, sardines, pilchards, smelt) and, polychaetes (marine worms). In captivity, typical fish species fed to penguins include capelin, herring, mackerel, silversides and smelt.

In my experience, issues in captive penguin nutrition are similar to those of any wild species kept in captivity. However, there are some issues specific to penguins as piscivores and, in this article, I will focus on:

1. Prey: freshwater versus cold water (marine)
2. Dietary supplements
3. Hand-feeding versus foraging

Prey: Freshwater versus Cold Water (marine)

Penguin species are cold water (marine) foragers, therefore their prey species are those found in marine waters. Marine prey species have some important nutritional differences as compared to prey found in freshwaters. One of the primary differences is the amount and types of dietary fat and fatty acids.

Dietary fat and fatty acids for marine birds such as penguins are directly related to feather quality and water-proofing of feathers. These fats and fatty acids are high in unsaturated fats and they are an excellent source of energy with more than a 90% digestibility for most piscivore species.

First, it is important to know that the fat content in any fish species from freshwater or coldwater environments can differ according to life stage. For example, the carcass fat content can vary from 1% after spawning to more than 20% before spawning.

Second, the storage of fat differs between cold water and freshwater species . Coldwater fish species are "oily" fish and fat is stored in muscle. Fish species from freshwaters are "nonoily" fish meaning fat is stored in the liver (not the muscle). This can be an important difference if a captive piscivore like the penguin is fed only freshwater, eviscerate fish meaning the liver is removed - and so is the fat. The result is a diet that will lack in overall fat content and be deficit in essential fatty acids.

Lastly, coldwater and freshwater fish species also differ in the fatty acids they provide. Krill and herring from cold water environments have high levels of timnodonic acid (C20:5), eicosapentaenoic acid (C20:5(n3) or EPA), and docosahexaenoic acid (C22:6 or DHA). Squid (coldwater) is high in caproic acid (C6:0 or hexanoic acid) and the level is as much as two to four times higher relative to other prey items whether the comparison is for coldwater or freshwater prey species. Freshwater fish contain twice the level of capric acid (C10:0 or decanoic acid) and C:18 fatty acids (linoleic and linolenic). Compared to coldwater prey, freshwater prey has less than half the quantity of C20:4 (arachidonic) and only one-seventh the quantity of C22:0 (behenic or docodanoic acid).

Photo Credit: National Geographic

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It is important to understand that a species that evolved on diets high or low in specific relative amounts of fatty acids will flourish in captivity only when they are provided with the fatty acid spectrum suitable for their evolutionary physiology. A lack of the appropriate dietary essential fatty acids for captive penguin species can result in loss of feather quality, feather water-proofing and dysfunction of the uropygial (preen) gland. Penguins with poor feather quality and lacking feather water-proofing may avoid water and may have trouble maintaining body temperature.

Penguin species, like many avian species, have an uropygial gland (preen gland) that secretes the sebum that the bird smears onto feet and feathers as a protectant and water-proofing agent. This sebum is composed of fatty acids, mucins, lipids and glycerides and, in addition to water-proofing feathers, sebum is also a pheromone, protects against ultraviolet (UV) light and, it is part of the immune system protecting against bacteria and fungi. Although research has not yet reliably reproduced dietary factors that predict the composition of preen gland sebum, we do know that diet is related to sebum composition. Therefore, the lack of an appropriate diet - especially fats and fatty acids - can affect preen gland function; affect feather quality and water-proofing,; could interfere with social and reproductive success (pheromones) ; and, could also result in numerous health problems related to UV exposure and opportunistic bacteria and fungi.

Photo Credit: National Geographic, Emperor Penguin Embryo

Dietary fats and fatty acids are also essential for successful reproduction in terms of embryonic growth and chick growth. The energy needs of developing embryos are provided by yolk sac fats and fatty acids that are directly related to the diet of the adult female up to at least three months prior to egg laying. In addition, there is research evidence that the reproductive success of the developing embryo as an adult is also directly related to the nutritional status of the adult female at egg-laying.

Dietary Supplements

Animals fed aquatic prey should be supplemented with thiamin and vitamin E daily . The recommendations are a minimum thiamin (vitamin B_1) at a rate of 30 mg/kg fish as fed (wet weight) ***and*** tocopherol (vitamin E) at a rate of 100 IU/Kg fish as fed (wet weight).

Thiamin. Thiamin is an essential vitamin meaning it must be obtained from the diet because it is not made or stored in the body. The recommendation to supplement with thiamin is based on the loss of thiamin and the presence of thiaminase in aquatic prey. Thiamin is a fragile vitamin, easily destroyed in food sources by handling and storage. Since many zoological institutions have to order their fish and other aquatic prey in large shipments, the shipments are often stored in freezers for three to six months. Freezing, and thawing, can deplete the thiamin levels in a carcass. Thiaminase, an enzyme that breaks down and destroys thiamine, is found in many species of aquatic prey in various amounts depending on species, animal size and geographic location. Thiamin is necessary for the healthy functioning of nerves, muscle, immune system and metabolism. Symptoms of a thiamin deficiency can include fatigue, anorexia, respiratory problems, irritability, immune dysfunction, neurological disease and cardiovascular disease.

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Vitamin E. Vitamin E is a fat-soluble vitamin, stored in the body, and it functions as an antioxidant with a role in metabolizing fatty acids. It is also protective of the unsaturated fatty acids in cellular membranes. Vitamin E loss in aquatic prey carcasses is primarily due to handling and storage. Freezing results in progressive loss of vitamin E. A deficiency of vitamin E can result in neurological problems, immune and muscular dysfunction, anemia and retinopathy.

Other Supplements. At present, there is a lack of consensus regarding the supplementation of penguins with vitamins and minerals other than thiamin and vitamin E. In my opinion, if penguins are fed appropriate, whole-carcass, quality prey (bones and viscera) and supplemented with thiamin and vitamin E at recommended levels, they do not need other supplements.

Feeding Dietary Supplements. Each animal must be hand-fed a prey carcass with the appropriate daily supplement to ensure that every animal receives their daily dose - no more, no less than the appropriate dose. Thiamin supplements should not be put in the fish until fed to ensure that thiaminase in the carcass does not degrade the supplement.

Hand-feeding versus Foraging

The major difficulty when feeding a group of any species is to ensure that each animal receives the appropriate amount of food and/or supplements. Hand-feeding is the only way to ensure that all animals in a group ingest enough food according to their caloric requirements and receive their daily supplementation. In addition, hand-feeding limits spoilage due to environmental temperatures and debris as well as fecal contaminants.

Opportunities to forage, however, are necessary for environmental enrichment and to allow penguins to exhibit natural behaviours, exercise and have challenges. Below are websites for some videos on foraging and hand-feeding for penguins. Please note that any items used to encourage foraging and/or for environmental enrichment must be non-toxic and designed to avoid entrapment or injury.

Foraging activities for penguins:

https://www.youtube.com/watch?V=HfVx6oXJq8g
(Youtube “penguin enrichment Odense Zoo” if the link does not work)

https://www.youtube.com/watch?v=YI8AJBc1FJ4
(Youtube “Captive penguins chase live fish” if the link does not work)

Hand-feeding video:
Please note how they track feed intake and vary quantity according to individual appetite.

https://www.youtube.com/watch?v=IjwsFRzntFk
(Youtube “Penguin feed at Audubon Aquarium of the Americas” if the link does not work)