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IN PRAISE OF CHLOROPLASTS AND MITOCHONDRIA: SOME THOUGHTS ON MUTUALISM IN WILDLIFE HEATH MANAGEMENT

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Brief Biography

Dr. Leighton is the Executive Director of the Canadian Cooperative Wildlife Health Centre (CCWHC), a science centre for wildlife disease surveillance, management, research and teaching among Canada's five veterinary colleges, governments and non-government organizations, and a Collaborating Centre of the World Organization for Animal Health (OIE). He received an AB degree from Cornell University in 1970 and a DVM from the University of Saskatchewan in 1979, after which he did post-graduate study in veterinary pathology at Cornell University leading to a PhD and certification by the American College of Veterinary Pathologists in 1984. Dr. Leighton joined the faculty of the Department of Veterinary Pathology at the Western College of Veterinary Medicine at the University of Saskatchewan in 1984 and was Department Head from 1988 to 1999. He became the full-time Executive Director of the CCWHC in 2002. His research and publications have included pathology and epidemiology of non-infectious and infectious diseases of wild animals, disease surveillance, disease management, interpretation of science to the general public and advocacy for more engagement by the veterinary profession in important global concerns.

CONSERVATION OF BLACK-FOOTED CATS (*Felis nigripes*) AND PREVALENCE OF INFECTIOUS DISEASES IN SYMPATRIC CARNIVORES IN SOUTH AFRICA

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Abstract

The black-footed cat (*Felis nigripes*) is a small (~2 kg) felid with a limited range in southern Africa. This species is included on Appendix 1 of CITES, is listed as Endangered by the U.S. Fish and Wildlife Service, and is ranked as the most vulnerable of the Sub-Saharan cat species by the Cat Specialist Group of the International Union for the Conservation of Nature (IUCN). This project is part of a larger conservation initiative to better understand the ecology, genetics, health, and reproductive biology of the black-footed cat in southern Africa. From 2004-2009, the Black-footed Cat Working Group captured 18 free-living black-footed cats from 2 study sites. Six cats were recaptured and a total of 26 serum samples obtained. Serum (n = 87) samples were also collected from small carnivores that share black-footed cat territory, prey base, and opportunities for disease exposure including one African wild cat, three domestic cats, two domestic dogs, six Cape foxes, five bat-eared foxes, three black-backed jackal, seven aardwolves, and 34 yellow mongoose. Serologic evidence of exposure to viral pathogens that commonly infect canids and felids was low for all viruses except canine distemper virus (CDV). The species with the highest CDV seroprevalence was yellow mongoose which demonstrated a dramatic decrease in seroprevalence from 2005 to 2009. Attempts to identify canine distemper virus from biological specimens using molecular diagnostic techniques to determine if the virus was present in asymptomatic carriers are ongoing. These data should help to better understand the epidemiology of canine distemper virus and its potential impact on small carnivore populations.

YAWS: AN EMERGING ZOONOSIS OF GORILLAS?

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Abstract

Yaws (*Treponema pallidum* sbsp. *pertenue*), a neglected tropical disease of humans, may be present in several populations of western lowland gorillas (*Gorilla gorilla gorilla*) in the Republic of Congo and Gabon. Yaws causes severe skin and skeletal deformities in humans, which can limit mobility. Gorillas with gross lesions that are similar to human yaws cases were observed in Odzala National Park in the Republic of Congo, where the syndrome appeared to limit reproductive success of adult male gorillas.[1]

Evidence for existence of treponemal diseases in non-human primates, particularly gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes troglodytes*), has mostly been based on skeletal pathology;[2] however, Karesh (2000) tested four western lowland gorillas in the Parc National d'Odzala-Kokoua which were positive for treponemal antibodies.[3] Treponemal diseases are morphologically identical and all four diseases (yaws, bejel, pinta, syphilis) induce seroreactivity on standard serologic tests for syphilis; thus, differentiating the causative organism based on serology alone is problematic. A treponemal isolate from a wild baboon (species not identified) was found to be closely related to human yaws.[4] Experimental infections of humans with this isolate caused active infections, leading to concerns that primates may serve as reservoirs for zoonotic treponemal pathogens; studies should be completed to rule out the bushmeat trade as a potential source of transmission.[5] A second study found that the simian strain from the wild baboon was indistinguishable phylogenetically from human yaws.[6] Additional molecular studies are needed to differentiate cross-species transmission in great apes versus co-evolution of the pathogen.

A pilot surveillance program was carried out in Langoue Bai, Ivindo National Park, Gabon, showing a prevalence rate of 50% of the 18 adult gorillas fitting the case definition for a yaws-like syndrome. A case definition of yaws in humans is a person who lives in an endemic areas and presents with one or more of the following signs: ulcer with scab, papillomas, and palmar/plantar hyperkeratosis.[7] Gabon, and other west and central African countries are endemic for yaws.[8] Other tropical skin diseases such as Buruli ulcer may have similar lesions. Dermatopathy of some kind was visible on 16/18 adult gorillas. No lesions were visible in the juvenile and infant populations (n=10). Despite the fact that an effective cure is available for treponemal diseases, the geography of the Langoue Bai would make intervention difficult if the etiology of the disease is indeed a treponemal organism. Reinfection would be very likely even

if intervention were attempted. In addition to collecting pilot data, this study involved capacity building by training Gabonese field workers in collecting data to monitor gorilla health.

ACKNOWLEDGMENTS

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CONSERVATION IN THE OUTBACK

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Abstract

Arid Recovery is a unique conservation initiative based in the South Australian outback and is primarily supported by BHP Billiton (Olympic Dam), South Australian Department for Environment and Heritage, The University of Adelaide and the local community.[1] A focal point of this initiative is the feral-proof fenced Arid Recovery Reserve which covers a total area of 123 km^2, of which 60 km^2 is free from feral cats, foxes and rabbits. These species were completely removed from the reserve in 2001 by a combination of 1080 poisoning, warren fumigation, trapping and shooting.[1] The removal of these feral species has allowed regeneration of native plants and re-establishment of native mammal populations within the reserve. Locally extinct, threatened mammal species, including the greater stick-nest rat (*Leporillus conditor*), burrowing bettong (*Bettongia lesueur*), greater bilby (*Macrotis lagotis*) and western-barred bandicoot (*Perameles bougainville*), have also been successfully reintroduced into the reserve. There is ongoing control and removal of cats and foxes in a 200 km^2 unfenced area adjacent to the reserve, so that wild populations of bilbies can be established in this area.

There are multiple ongoing monitoring projects conducted within and surrounding the Arid Recovery Reserve. Populations of the burrowing bettongs, greater bilbies, greater stick-nest rats and western barred bandicoots are monitored through quarterly track transects and annual cage trapping. Tracks are swept the day before counting with a chain dragged behind a quad bike. All tracks that cross over this dragged line are then counted the following day. Any reintroduced species trapped has body weight, sex, reproductive status and pes length recorded and a unique identification number given to the animal either through microchipping or ear tagging. Tail width is also recorded for burrowing bettongs. All trap data are entered into a database. Bilby and bettong burrows are monitored annually for activity, size and co-occupants. Similarly, greater stick-nest rat nests are monitored twice a year. The number of tracks and presence of fresh scats are just some parameters used to determine the activity of each burrow and nest. The successful establishment of these thriving populations of all four reintroduced species has been confirmed by these regular monitoring methods.

Research is also a large component of Arid Recovery. Current investigations include the role of dingoes in controlling cat and fox numbers by studying the interactions among dingoes, cats and foxes in a 37 km^2 fenced enclosure using GPS collars on these species. A one-way gate is also being designed and trialed to allow greater bilbies and burrowing bettongs to naturally disperse into areas where they are currently not inhabiting. This could overcome the unnatural barrier to dispersal formed by the fence that can lead to overstocking. Different gate designs are being

tested on feral cats to ensure that they cannot gain entry. There are also more projects planned to help understand the ecology and health status of the reintroduced species. The current research priorities include comparing founder stock genetics of reintroduced species with that of the current population to investigate the genetic diversity within these species. Samples have been collected from the ear of each species during regular trap sessions, and these have been stored for genetic testing. Another research priority involves investigation of the impact of mining on the reintroduced species. This is important as the Arid Recovery Reserve is located near the BHP Billiton Olympic Dam mine site, which is currently the largest underground mine in the southern hemisphere.[2] Olympic Dam mines uranium, copper, gold and silver and while there is no evidence to suggest that the reintroduced species are showing any signs of heavy metal toxicity, it is important to investigate if proximity to the mine-site is a threat to the long-term survival of these species and establish some baseline data before the planned expansion of the Olympic Dam mine.

The main objectives of the project investigating impacts of mining on the reintroduced species included a literature review on heavy metal toxicity in mammals and identification of the main clinical signs, both immediate and long-term, associated with exposure to different levels of heavy metal contamination. The literature review revealed that signs of heavy metal toxicity reported in terrestrial mammals include decreased hematocrit and hemoglobin levels, pathologic changes in red blood cell morphology, changes in blood urea/creatinine levels, increased metallothionein levels, changes in liver enzymes, decreased body and/or organ weights, histopathologic changes in organs and increased frequency of chromosomal aberrations. The literature review was then used to develop a pilot study involving blood collection from the burrowing bettongs and performing the most cost-effective tests such as morphologic evaluation of blood smears using light microscopy. The pilot study enabled development of a protocol for blood collection from the lateral tail vein of burrowing bettongs. Blood smears examined from the pilot study showed no significant abnormalities in red blood cell morphology and white blood cell differential counts. The study has also revealed the lack of research to establish normal reference ranges for hematologic values in burrowing bettongs. The pilot study will form the basis of further investigations into heavy metal burdens in reintroduced fauna within the reserve as well as help to establish a baseline database.

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PREVALENCE OF RABIES ANTIBODIES IN NEOTROPICAL BAT COMMUNITIES IN FRAGMENTED LANDSCAPES IN PUEBLA, MEXICO

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Abstract

Habitat loss and fragmentation have favored biodiversity loss, changes in species assemblages and changes in the frequency of emerging and re-emerging zoonoses, such as rabies. Rabies virus has been isolated from different species of bats; however, the natural history and the way the virus is maintained in bat communities remain unknown. The aim of this study was to find out the effects of habitat loss and fragmentation on rabies prevalence in bat communities in different habitat types in fragmented landscapes in Puebla, Mexico. We compared bat diversity and infection prevalence in three habitat types (interior, edges and pastures) within four vegetation types (forest, mature acahual, young acahual, and grassland) in six fragments varying in size and isolation. We obtained blood samples from 194 bats belonging to 3 families, 12 genera and 15 species. Species diversity was higher in grasslands (0.89 Simpson index), followed by forested areas (0.87) and edges (0.82). *Sturnira lilum* was the most common captured species in forested areas (28%) and edges (38%) while *Sturnira ludovici* dominated in grasslands (19%). Blood samples were analyzed at the National Center of Veterinary Microbiology, INIFAP and the Enzyme-Linked Immunosorbent Assay ELI-Rab was performed. A total of 20% of captured bats were positive for rabies antibodies. Antibody prevalence at pastures sites was 27% followed by interior (22%) and edges (14%) without statistic significance ($X^2 = 1.94$ $d.f.= 2$, $p > 0.05$). Prevalence of rabies antibodies was highest at mature acahual vegetation type at 34% followed by young acahual (17%) and forest (8%), and were significantly different ($X^2 = 9.9$ $d.f.= 2$, $p < 0.05$). The high seroprevalence indicates that rabies virus is endemic in these bat communities and that these species are refractory or able to recover from rabies virus infection. Further studies are needed to understand the role of each species in viral maintenance. At this local spatial scale, our study concluded that the ecosystem is highly homogeneous. Further studies are needed to understand the effects of habitat loss and fragmentation on the bat community assemblages and on the rabies infection dynamics in tropical areas where agricultural activities are established.

ASSOCIATION AMONG LEPTOSPIRAL SEROVARS, NATIVE AND EXOTIC RODENTS FROM COZUMEL ISLAND, MEXICO

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Abstract

Oceanic island ecosystems are used as models for ecological studies because they are sensitive to human activities and especially vulnerable to exotic species and pathogen introductions.[1-3] *Leptospira* was selected as a model to identify possible host-pathogen interactions based on the recognized serovars-host relationships, specifically by looking at the relationships among native fieldmouse (*Oryzomys couesi cozumelae*) and introduced (*Mus musculus* and *Rattus rattus*) rodent populations, and the seroprevalence (SP) of six *Leptospira* serovars (Australis, Ballum, Canicola, Autumnalis, Icterohaemorrhagiae and Hardjoprajitno) in the Mexican Island of Cozumel. Sera samples (*Oryzomys* n = 66, *Mus* n = 156 and *Rattus* n = 57) were analyzed by the microagglutination test (MAT). The most seroprevalent (all species together) with average MAT titers ≥ 1:100, were: Australis (73%), Canicola (66.5%) and Ballum (42%). Icterohaemorrhagiae and Autumnalis had SP < 26% with average MAT titers < 1:50 and were assumed to be nonspecific reactions. All tests were negative for Hardjoprajitno. Australis SPs ranged from 67% to 75% among the three species and were not significantly different by chi-square test ($p > 0.05$). Significant differences were observed for Canicola, where *Oryzomys* and *Mus* (mice species) had SP > 71% while *Rattus* had 14% ($p \leq 0.05$). Similarly, for mice species Ballum SP ranged from 39% to 49%, while the *Rattus* had a SP of 23% ($p \leq 0.05$). Simple logistic regression was used to explore associations between SPs and rodent characteristics (species, capture area, age and sex). The observed seroprevalences suggest rodents, introduced or native, serve as reservoirs for pathogenic *Leptospira* spp. Results for serovars Australis and Ballum indicate a host-adapted serovar relationship (SP > 50% and average titer > 1:100), the former serovar with the three species, whereas for Ballum only with mice. Canicola SPs were mostly found in both mice species and illustrate a host-accidental serovar (SP > 60% and the highest average titer), and these serovar SPs could be the consequence of each rodent species behavior and its interaction with dogs and raccoons on the Island. The SPs were greater in urban areas, and lowest in the natural areas. In Cozumel, rodents could play a role in risk for infection to other native and domestic mammals, or humans. Surveillance, isolation, and molecular characterization of *Leptospira* spp. should be performed to increase understanding of the serovar and host relationships, and related risk in Cozumel Island.

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MANAGEMENT OF SYLVATIC PLAGUE, (*Yersinia pestis*) IN PRAIRIE DOGS (*Cynomys* spp.): RESEARCH UPDATES

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Abstract

Plague, a zoonotic disease caused by the bacteria *Yersinia pestis* (Fam. Enterobacteriaceae) entered the United States more than 100 yr ago.[1,4] Prairie dogs (*Cynomys* spp.) and other rodents such as ground squirrels serve as epizootic hosts and suffer high rates of mortality, but true enzootic hosts are still unidentified in many ecosystems.[1-3] Prairie dogs are a keystone species in prairie ecosystems, and their loss affects other species, such as the endangered black footed ferret (*Mustela nigripes*).[5] Vector control, although successful in controlling outbreaks, is labor intensive, costly, and often applied too late to be effective. Oral vaccination of prairie dogs against plague could provide a feasible alternative. Laboratory challenge studies have shown that oral vaccination of prairie dogs using a recombinant raccoon poxvirus expressing plague antigens provides significant protection against *Y. pestis* challenges that simulated simultaneous delivery of plague bacteria by numerous flea bites.[6] Before field application is considered, a delivery bait that is palatable to prairie dogs, resistant to environmental conditions, and capable of maintaining vaccine titer must be selected, along with an appropriate biomarker to evaluate uptake by animals. In our latest studies, we tested bait candidates, determined that peanut butter was the preferred bait flavor, and found that consumption of vaccine-laden baits resulted in protection from plague challenge. We also demonstrated that rhodamine B included in baits at a concentration of 0.25% is a safe and effective systemic marker in prairie dogs, providing a simple and reliable method to monitor oral vaccine uptake in future field trials.

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UNDERSTANDING LEAD: ECOSYSTEM AND POLICY ASPECTS

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Abstract

Society has long understood the toxicity of lead (Pb) to humans,[21,29] but lead poisoning in animals is far less well documented. It was not until late in the 19th century that the first reliable reports of toxicity in domestic animals and wildlife appeared.[8,32] During much of the 20th century lead was marketed as a wonderful material of many uses. It took heroic efforts by physicians like Alice Hamilton and Herbert Needleman and researchers like Clair Patterson to build the scientific foundations necessary to implement significant policy change. By the late 1970's lead had been eliminated from most gasolines and household paints and average blood lead had begun to decline in the U.S. population.[2] Subsequent regulations also brought about modest restrictions on other uses of lead including solder, ceramic glazes and a host of other products in an effort to protect human health. But a great many products containing lead remain on the market.

After an initial drop in lead use in the U.S. in the late 1970's, the amount of lead mined, smelted, manufactured into products and marketed in the U.S. has remained remarkably constant from the early 1980's through the present day.[31] Currently the major use of lead in the U.S. and most developed countries is for lead acid storage batteries. It is difficult to find precise numbers, but roughly 8% of lead use in the United States goes into fishing gear, bullets and shot for firearms.[3] It should be noted that although there has been a gradual decline in the sales of hunting and fishing licenses in the United States over the last 30 yr, there has been a dramatic increase in participation in the non-hunting shooting sports (target, trap, skeet, etc.).[33] These activities continue to deposit many thousands of tons of lead into the environment each year.[30,33] Mining, smelting, manufacture and recycling also contribute significantly to environmental pollution. This is a more significant problem in many developing countries.[4,9,33]

The veterinary literature contains abundant case reports of lead poisoning in domestic species, but few large-scale epidemiologic studies exist.[18] In the realm of wildlife, significant mortalities in waterfowl have been documented for over 100 yr,[8] but it was the threat of lead poisoning to bald eagles (*Haliaeetus leucocephalus*) that brought about the adoption of non-toxic shot for waterfowl hunting in the U.S. in the late 1980's.[1,33] In the U.S. nearly all bullets and shot used for hunting upland game birds and mammals (as well as for the shooting sports) are still made from lead.[33] Even today, large numbers of eagles, loons, waterfowl, raptors and many other species die annually from ingesting lead used for hunting and fishing activities.[11,17,22,24,25,28,33] For one endangered scavenger, the California condor (*Gymnogyps californianus*), lead poisoning

has been shown to be a major mortality factor that is significantly limiting the success of reintroduction efforts.[33]

Although clinical lead poisoning is still an important disease in human medicine, a great deal of recent research has focused on the sublethal, chronic effects of lead. Significant clinical effects on many systems have been documented including blood pressure and the cardiovascular system, reproductive system, renal function, the hematopoietic and immune systems, and both the central and peripheral nervous systems, including significant detrimental effects on learning, control of aggressive behavior, sensation and fine motor control, etc.[10,23,26]

Thus far, relatively little work has been done on sublethal effects in non-human vertebrates, but those studies that do exist document similar effects on a wide variety of vertebrates including mammals, birds, reptiles, amphibians, and fish.[13] Deficits in cognitive skills have been reported in children with blood lead concentrations as low as 5 μg/dL.[15] Another study found that a net increase of 1 μg/dL in the lifetime average blood lead level was correlated with a loss of 0.46 IQ points.[7] Cognitive effects of sublethal lead poisoning are beginning to be studied in wildlife. Effects on locomotion, food begging, feeding, treadmill learning, thermoregulation, and individual recognition were observed in herring gull (*Larus argentatus*) chicks dosed with lead acetate to produce feather lead concentrations equivalent to those found in wild gulls.[5] Several studies have found an association between sub-clinical lead toxicosis and delinquent, antisocial, and aggressive behaviors in humans.[19,20,27] Similarly, the development of aggressive behaviors has been documented in domestic dogs and cats with elevated blood lead levels, as well as songbirds exposed to heavy metals.[12,14,16] Hatchling turtles exposed to environmentally relevant lead concentrations showed physiologic and behavioral changes that would dramatically reduce their survival in the wild.[6] Environmental lead exposure at low levels could be contributing to wildlife mortality by hindering the complex mental processes and social behaviors required for reproduction, migration, and a host of other activities.

Most people do not have to be convinced that lead is toxic, but it has been difficult to turn this understanding into integrated and cogent policy. To protect common loons from lead toxicosis, educational and legislative efforts have been made by loon groups in several states to encourage anglers to switch to non-toxic fishing gear. At the same time, other groups are working hard to educate the public and policy makers on risks to birds of prey and swans from ingested lead. Child health advocates and state & federal agencies spend millions of dollars each year to educate the public about the continuing dangers of lead paint exposure in older housing. Consumer safety groups try to gather data and issue alerts on potential dangers from lead in toys, traditional medicines, imported food and cosmetics. Occupational health agencies regularly deal with issues of worker exposure to lead in mining, manufacturing and recycling industries, as well as with segments of the construction industry. As a society, it seems that we have segmented both our knowledge about lead poisoning and attempts at education and regulation. It is uncommon for veterinarians, physicians, public health professionals, occupational health specialists and other interested parties to come together share their knowledge and attempt to find common solutions to the many problems associated with lead toxicosis.

There is still a great deal of work that needs to be done to protect humans and other animals from

the threat of lead poisoning. Zoo and wildlife veterinarians can play a crucial role in gathering the data and performing the studies that will bring about policy change. Future research on lead toxicosis should consider the following four points:

1. The effects of lead poisoning are similar among vertebrate species and it is reasonable to (cautiously) extrapolate among taxa.
2. Clinical lead poisoning is underreported in both domestic animals and wildlife and many of the subclinical effects of lead are often missed.
3. A major impediment to recent policy initiatives is the disciplinary separation that exists among groups investigating issues related to lead poisoning.
4. While the concept of using animals as sentinels of human health is not new to conservation medicine, wildlife professionals may not realize the wealth of information that can be gained by taking the opposite approach and using humans as indicators or sentinels for animal and environmental health, particularly in the area of sublethal effects.

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CHASING VIRUSES: ADVENTURES OF AN INFECTIOUS DISEASE COWBOY

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Brief Biography

Joseph B. McCormick, MD is Regional Dean, Brownsville campus of the University of Texas School of Public Health. He was raised on a farm in Indiana. After graduating cum laude from Florida Southern College with majors in chemistry and mathematics, he attended the Alliance Francaise and the Free University in Brussels in preparation for teaching sciences and mathematics in French in a secondary school in the Congo. There in the local hospital he was introduced to medicine, particularly tropical medicine. He entered Duke Medical School in 1967 graduating in 1971 with an intercalated MS from Harvard School of Public Health (1970). His internship and residency were at Children's Hospital of Philadelphia under Dr. C. Everett Koop. In 1974 he became an Epidemic Intelligence Service Officer (EIS), at the CDC, and a fellow in Preventive Medicine. He was a PAHO/CDC consultant for the Brazilian government for the extensive meningitis outbreaks of 1974/6.

In 1977 he went to West Africa to found the CDC Lassa fever Research Project in Sierra Leone, where he received an emergency call to join the team investigating the first Ebola epidemic in 1976 and again in 1979. In Sierra Leone he conducted extensive and definitive studies of the epidemiology and treatment of Lassa hemorrhagic fever, publishing a landmark publication in the New England Journal of Medicine on effective antiviral treatment for this disease. He returned to Atlanta in 1979 and became Chief, Special Pathogens Branch, Division of Viral Diseases at the CDC, directing the Biosafety level 4 laboratories for 9 yr. He became involved in AIDS and led the original team that did the first AIDS investigation in Africa and established the Project SIDA in Kinshasa, Zaire, and later the Project Retro-Ci in Abidjan, Ivory Coast. He co-authored numerous papers in major journals, including Science, and established a key point in the natural history of HIV infection in Africa by testing specimens saved in his laboratory from the 1976 Ebola outbreak from which the oldest HIV virus was isolated. In 1983 he identified the virus that causes Hemorrhagic Fever with Renal Syndrome (Hantavirus) in his laboratory at CDC. He later did pioneering work on the epidemiology and virology of Hantavirus, Lassa virus and Ebola virus.

In 1993, he became Chairman, Community Health Sciences Department, at the Aga Khan University Medical School (AKU) where he established an epidemiology program, resembling the CDC Field Epidemiology Training Programs, and a Masters' degree in Epidemiology. Over 45 papers have now been published by faculty and trainees from this period. In 1997 he moved to France where he founded epidemiology programs for the Institute Pasteur and for Aventis

Pasteur. He returned to the US in 2001 to start a new regional campus of the UT Houston School of Public Health in Brownsville, Texas where he is the Regional dean and the James H. Steele professor of epidemiology. His awards include the USPHS Meritorious Service Medal, and humanitarian awards from Florida Southern College and Duke University Medical School, and Friend of Public Health award from the Texas DSHS. Dr. McCormick has over 220 scientific publications with co-authors from over 20 different countries. He has acted as reviewer for many journals, and has contributed to television, newspapers and periodicals and is featured in several books for the lay reader (e.g.,The Coming Plague, The Hot Zone). With his wife, Sue Fisher-Hoch he co-authored a popular account (Level 4, Virus Hunters of the CDC) of their adventures that was translated into seven languages, and has been reissued in hard cover and paperback. He is an accomplished amateur pianist, and enjoys outdoor activities such as running, back packing, skiing and fly-fishing.

BEYOND FENCES: POLICY OPTIONS FOR BIODIVERSITY, LIVELIHOODS AND TRANSBOUNDARY DISEASE MANAGEMENT IN SOUTHERN AFRICA

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Abstract

Southern Africa has a disproportionately high fraction of global biodiversity, found across a range of arid and semi-arid ecosystems. Thirteen potential and existing terrestrial Transfrontier Conservation Areas (TFCAs) have been identified in this region, many encompassing national parks, game reserves, hunting areas, and conservancies embedded within a matrix of land under traditional communal tenure.[4] The existing and proposed TFCAs cover more than 1,200,000 km^2 and include within their borders many of sub-Saharan Africa's highest priority biodiversity conservation areas.[4]

AHEAD (Animal & Human Health for the Environment And Development) is a program of the Wildlife Conservation Society (WCS) and partners focused on problems facing biodiversity conservation and development in such large, transboundary landscapes from the critically important perspective of the linkages among wildlife health, domestic animal health, and human health and livelihoods.[3] One current area of focus is the Kavango-Zambezi Transfrontier Area (KAZA TFCA), on the verge of becoming perhaps the world's largest conservation-oriented landscape. The development of TFCAs to further the conservation of biodiversity and sustainable development through the harmonization of transboundary natural resource management is a priority for SADC (the Southern African Development Community) and the five countries that encompass KAZA: Angola, Botswana, Namibia, Zambia and Zimbabwe. Agr eement has been reached on creating a transfrontier area spanning approximately 400,000 km² and encompassing more than 70 national parks, game reserves, community conservancies and game management areas. The area contains the largest contiguous population of elephants (approximately 250,000) on the continent and will include, for example, the Caprivi Strip, Chobe National Park, the Okavango Delta (the largest Ramsar site in the world) and the Victoria Falls (World Heritage Site).

The primary economic driver behind the creation of TFCAs like KAZA is nature-based tourism that seeks to maximize returns from marginal lands in a sector where southern Africa enjoys a global comparative advantage.[1,2] In fact, nature-based tourism now contributes approximately as much to the gross domestic product in SADC countries as agriculture, forestry, and fisheries combined – a remarkable and relatively recent development highlighted by the 2004 *Millennium Ecosystem Assessment*.[4] Consequently, a key strategy for biodiversity conservation in southern African TFCAs is securing biological connectivity across larger landscapes in which the region's

core protected areas increasingly are facing the threat of becoming isolated ecological islands in agricultural landscapes, with the loss of connectivity so important to maintaining genetic diversity and the viability of globally endangered wildlife populations. Enhanced connectivity across large landscapes such as the KAZA TFCA is also considered to be a crucial factor in biological adaptation to climate change in the region.

Unfortunately, loss of important habitat corridors through land-use restrictions, driven by disease control requirements, contributes to ongoing habitat fragmentation and the loss of traditional migratory and dispersal routes in the region.[4] Present animal disease controls depend in large part on hundreds of kilometers of game-proof fences and strict regulation of local and export markets for animal products. These disease control fences and the physical and land-use barriers they create pose one of the greatest threats to transboundary connectivity and the vision of vast conservation landscapes that seeks to foster both conservation and livelihood benefits in largely semi-arid lands that may be considered marginal for agriculture.[4]

The management of wildlife and livestock diseases (including zoonoses) within KAZA remains unresolved and an emerging policy issue of major concern to livestock production, associated access to export markets, and other sectors, including public health. The TFCA concept promotes free movement of wildlife over large geographic areas, whereas the present approach to the control of transboundary animal diseases (TADs) is to prevent movement of susceptible animals between areas where TADs occur and areas where they do not, and to similarly restrict trade in commodities derived from animals on the same basis. The TFCA concept and current internationally accepted approaches to the management of TADs are therefore largely incompatible – a key threat to transboundary conservation success and risk-diversification of land-use options and livelihood opportunities in the region.[4]

The *AHEAD* program, launched in 2003, aims to help resolve these issues and contribute to the conservation of biodiversity and the enhancement of livelihoods of the rural poor in KAZA. This can be accomplished by helping to create an enabling environment for enhanced cooperation among conservation, agriculture and human health experts and authorities within and between member countries, by identifying mechanisms for controlling TADs without complete reliance on current fencing approaches, and by informing and influencing cross-sectoral and transboundary policy responses that support both TFCAs and control of TADs.[3]

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IS TOXOPLASMOSIS A POTENTIAL EMERGING DISEASE FOR WILDLIFE, DOMESTIC ANIMALS AND HUMANS IN MONGOLIA?

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Abstract

The Pallas' cat (*Otocolobus manul*), a small-sized felid native to Central Asia, is uniquely susceptible among cat species to mortality caused by toxoplasmosis, possibly as a consequence of its evolutionary history. In our earlier research in Mongolia, we identified two wild Pallas' cats (2/15, 13%) that were seropositive for *Toxoplasma* exposure, but found no seropositive individuals among sampled domestic cats (0/15) and wild rodents (0/45).[1] In this follow-up study, we have expanded our survey in Mongolia to include humans and domestic hoof stock as well as wild birds and additional Pallas' cats and rodents. Serum samples from native Mongolians (n = 300) were obtained opportunistically from citizens providing blood for routine health exams. Blood samples also were collected from domestic sheep and goats (n = 300) in herds located at our primary field site in central Mongolia and on the grassland steppes of eastern Mongolia. Serum samples from two migratory bird species (bar-headed geese, *Anser indicus*; swan geese, *A. cygnoides*; n = 189) were collected in north-central Mongolia as part of the WCS-USAID Global Avian Influenza Network for Surveillance (GAINS) program. Additional rodent (n = 45) and Pallas' cat (n = 19) blood samples were obtained at the primary field site. Serum samples were assessed for *Toxoplasma* antibodies at a single titer (1:16-1:64, depending on species) using a latex agglutination test (Toxotest MT, Tanabe USA, Inc., San Diego, CA, 92111 USA).

Results indicated that only two of the sampled Mongolians (0.7%; 2/300) had antibodies to *Toxoplasma* while none (0%; 0/45) of the tested rodents and just a few (1.2%; 4/300) of the hoof stock had anti-*Toxoplasma* titers. Although only 1 of 19 (5.3%) adult Pallas' cats were seropositive, these findings, combined with our earlier data, confirm the existence of some undefined nidus for *Toxoplasma* exposure. Because migratory waterfowl had a very high seroprevalence (104 of 189 positive, 55.0%), we suspect that Pallas' cats may be exposed sporadically via ingestion of tissue cysts in these potential prey items or from other migratory bird species. These new findings support our contention that *Toxoplasma* is not truly an endemic

parasite of Mongolia but is likely a transient pathogen, perhaps as an intracellular stowaway in wild birds. The combination of an extremely cold and arid climate, high altitude, very few domestic cats and limited numbers of wild felids may compromise the ability of *Toxoplasma* to complete its natural life cycle. These results reinforce the importance of managing Pallas' cats, especially breeding age females, in a *Toxoplasma*-free environment in zoos to prevent fatal toxoplasmosis in newborn kittens. In a broader context, these findings may have major public health implications for both pregnant women and the livestock industry in Mongolia if *Toxoplasma* exposure increases due to changes in cultural practices (eg. increased ownership of domestic cats) and global climate (eg., warmer winter temperatures affecting *Toxoplasma* oocyst survival). Initiation of surveillance programs for susceptible human and animal populations in Mongolia could be warranted.

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HEALTH MONITORING OF CHIMPANZEES NATURALLY INFECTED WITH SIVcpz: BENEFITS FOR CHIMPANZEES AND HUMANS

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Abstract

The human immunodeficiency virus type 1(HIV-1) pandemic has prompted considerable interest in non-human primate models of acquired immunodeficiency (AIDS). Several wild chimpanzee populations are known to be naturally infected with simian immunodeficiency virus (SIV), including chimpanzees in Gombe National Park. However, the impact of this infection on chimpanzee health and longevity remains unknown. The chimpanzees of Gombe have been under continuous observation since the 1960's and individual life histories are available for many individuals. In 2004, pathology was added to ongoing observational health and non-invasive virologic monitoring of chimpanzees and sympatric primates at Gombe. On-site personnel were trained in necropsy techniques so that carcasses of naturally deceased primates could be thoroughly, yet safely, evaluated. Although the initial goal was to monitor the health of this population, the project provided a unique opportunity to study the pathogenesis of natural SIVcpz infection. Previous to these studies, natural SIV infections, including that of chimpanzees, were thought to be non-pathogenic. However, our studies revealed higher mortality rates as well as cases of SIVcpz-infected chimpanzees with AIDS-like immunopathology. Our findings thus suggest that SIVcpz may impact survivability of this endangered species. Ongoing research into viral and host factors responsible for disease progression may provide critical clues to understanding the mechanisms of AIDS. While collaboration is common between researchers studying the pathogenesis of human diseases in laboratory settings, this collaboration among veterinary and human health professionals and conservationists has the potential to increase our understanding of disease pathogenesis for the benefit of humans and wild chimpanzees.

THE APPLICATION OF BIO-MIMICRY STUDIES OF THE CARDIOVASCULAR SYSTEMS OF GIRAFFES AND ARBOREAL SNAKES IN THE DEVELOPMENT OF A MODIFIED BIVENTRICULAR ASSIST DEVICE (MBVAD)

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Abstract

Wind turbines are alternative sources of energy, but are contributing to increased mortalities of flying animals. Solar panels, fuel cells, and wind turbines located on kites may reduce these mortalities.[1,6] Hydrogen and oxygen from the kite's fuel cell are converted to water and electricity in the fuel cell reactor located on the ground.[2,11] However, pressure differentials of fluids due to changes in height represent major engineering hurdles that must be resolved before these kites can be located above the flight paths of birds and bats. To resolve these hurdles, a modified biventricular assist device (MBVAD) that mimics the bio-mechanics of the hearts of giraffes and arboreal snakes was developed.[3-5,9] The MBVAD utilizes micro-solenoid valves that mimic the function of the biological valves. Systolic and diastolic pressure in the water filled ventricles is induced by pneumatic expansion and contraction of rubber spheres.[3,10] This permits rubber tubes to transfer water from ground levels to the fuel cell of the kite, as well as conduct hydrogen and oxygen from a fuel cell on the kite to a fuel cell reactor on the ground. Therefore, the ecological drawbacks of wind turbines may be countered by the use of biological models to resolve engineering hurdles. Consequently, our experimental kite represents the product of One Science. It is an alternative energy production unit that was developed by integrating concepts from veterinary science, ecology, chemistry, biophysics and engineering.[7,8]

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ANTIMICROBIAL SUSCEPTIBILITY OF BACTERIAL ISOLATES FROM SEA OTTERS: ONE HEALTH

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Abstract

Despite decades of legal protection, southern sea otter (*Enhydra lutris nereis*) population recovery has been hindered by high mortality, including deaths of prime-aged adult animals. Up to 50% of sea otter mortality has been attributed to intoxications and infection by bacteria and parasites.[3,7] Potentially pathogenic enteric bacteria appear to be more prevalent along urbanized coastlines and near river mouths, suggesting that land-sea pathogen spread may be an important component of exposure to some bacterial species (Miller et al., 2010).[5] Some aspects of sea otter biology may make them especially vulnerable to infection by bacterial contaminants in polluted runoff. They feed near shore, often within or adjacent to coastal surface water plumes,[4,5] may rest and forage in sheltered embayments near human population centers,[2] display intraspecific aggression that often culminates in soft tissue trauma and sustained stress, and they consume large amounts of filter-feeding invertebrate prey that can bioconcentrate pathogens, including bacteria.[6]

Antibiotics are an important therapeutic tool for management of bacterial infections in stranded sea otters and for prevention of infection following invasive procedures in free-ranging otters. In the current study, susceptibility to commonly used antibiotics was determined for 126 isolates of 15 bacterial species or groups, from necropsied, live-stranded, and apparently healthy wild sea otters examined between 1998 and 2005. These isolates included both Gram-positive and Gram-negative strains of known pathogens, opportunistic pathogens and environmental flora, including bacterial species with proven zoonotic potential.

Sea otters are a superb marine sentinel species whose site fidelity and other characteristics allow identification of local sources of pollution that can effect the health of humans, domestic animals and other wildlife.[1] Results of this study point to potential sources of zoonotic infections in near shore waters heavily used for recreation and should help optimize selection of appropriate antibiotics for treatment of bacterial infections of sea otters, other marine species and humans in contact with them. Minimal evidence of antimicrobial resistance and no strains with unusual or clinically significant multiple-drug resistance patterns were identified in this study. An

increasing body of evidence suggest that recovery of sea otter populations in California may be dependent on mitigating a number of types and sources of pollution, including bacterial pathogens, and that they provide an excellent example of how the "One Health" concept may help bring about positive changes.

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BREEDING CENTERS AND "RESTAURANTS" – AN UPDATE ON THE VULTURE PROGRAM IN INDIA AND NEPAL

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Abstract

The decline of the once ubiquitous *Gyps* spp. vultures of India, Nepal and Pakistan and some initial work to conserve the species has previously been presented to the AAZV.[1] Some 6 yr after the establishment of the first breeding center, the collaborative conservation program has the feeling of being at the end of a first phase. The successful transition to its next phase is crucial if it is to achieve its long-term goals of release of birds back to the wild.

Much has been done to eliminate the cause of the decline, the NSAID diclofenac, but the rolling year-on-year vulture decline continues. Diclofenac residues are still being identified in carcasses at carcass dumps despite the drug having been banned by law in many of the range countries.

The relative nephrotoxicity of diclofenac when compared with meloxicam in vitro has been demonstrated.[2] Meloxicam appears to be safe in vultures and can be used therapeutically. However, replacement of diclofenac with meloxicam in the farming and veterinary communities has not been straightforward. In addition, ketoprofen, previously believed to be a potential alternative to diclofenac, has now been shown to be nephrotoxic to vultures.[3]

The author is involved with collaborative veterinary management at four breeding centers: three in India and one in Nepal. These are managed by in-country partners; the Bombay Natural History Society and National Trust for Nature Conservation respectively (A fifth center has been set up in Pakistan). Additional technical support, for both husbandry and breeding, has been provided by workers from UK zoological collections. The total number of birds of all three species (not including the 2010 breeding season) in the five centers is 283.[4] This falls short of the total number of founder birds, 100 birds of each species to maintain 90% of current heterozygosity, as determined in order to maintain long-term genetic diversity.[5]

Many of the birds are relatively young, having been taken under license as nestlings. Breeding has now occurred in the older birds from all three species held, namely the Oriental white-backed, the long-billed, and the slender-billed vultures (*G. bengalensis*, *G. indicus* and *G. tenuirostris*, respectively). For this year's breeding season, incubators were used for the first time. Several pairs had what would have been their first, and only offspring reared artificially and then went on to produce a second chick in the same season.

A major constraining factor on the project is cost, in particular when considering the number of years over which the captive-breeding program needs to run. A large proportion of these costs, supported by the UK wildlife charity the Royal Society for the Protection of Birds, is $150,000

per annum to feed the vultures. Alternative sources of meat have been researched, including wildlife casualties, with the risk to the project being critically assessed. Ongoing research indicates that an ELISA test to identify diclofenac residues in meat is feasible. The benefit of this would be to give, within the limitations prescribed by local religions, alternative sources of domestic livestock meat.

Highly-pathogenic avian influenza (HPAI) has been found in domestic species in the range countries, often close to the breeding centers. Formal approaches to the relevant government authorities have not succeeded in getting an embargo lifted on the importation and use of a killed HPAI H5N1 vaccine. Preventive measures are therefore currently limited to bio-security and wild bird exclusion.

In a collaborative project with local communities, Bird Conservation Nepal has established a facility loosely described as a "vulture restaurant" in a rural area. The site coincided with an extant group of vultures. A feeding area and bird-hide have been set up and an active diclofenac replacement program has taken place in the locality. Old cattle are purchased and held until they die, at which point they are fed to the vultures. This can be observed from the hide and visitors pay a fee which goes back into the local community. Vulture numbers have increased as birds have moved to the area and breeding is taking place. The drawback is that there is no confinement of the birds meaning they could fly some distance and consume a carcass containing fatal amounts of diclofenac. In a recent, high-profile government-supported event in order to highlight the plight of the vultures, over 50 liters and 13,000 boluses of diclofenac were destroyed.

The effects of the vulture decline extend into the local communities and affect community health. Without the vultures to dispose of carrion there has been a concomitant rise in stray dog populations. Linked to this has been an increase in the number of cases of human rabies, with one study attributing to this effect an estimated 47,300 deaths in the period from 1992 to 2006.[6]

The year 2010 sees the project enter a second phase; one of consolidation. A core function of the work is to maintain and breed vultures in captivity so that a release-program can occur. There are a few vultures left in the wild. The threat of NSAID toxicity means they remain at risk and, based on current trends, any or all of the three species could become extinct in the wild. However, the lobbying and advocacy needed to eliminate diclofenac from the environment should now be seen as much for ecosystem health and the generations of vultures to come as for the remaining survivors of these previously ubiquitous raptors.

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INVESTIGATING DISEASE IN DECLINING THICK-BILLED PARROT POPULATIONS IN NORTHERN MEXICO

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Abstract

Thick-billed parrots (TBPs) (*Rhynchopsitta pachyrhyncha pachyrhyncha*), listed in Appendix 1 of CITES as Endangered, once ranged from the southwestern United States to northern Mexico. Their current range is limited to the pine forests of Mexico's Sierra Madre Occidental. Current populations are threatened by habitat destruction and degradation. There is no information available regarding the role of disease in population declines. We hypothesize that climate change leading to changes in vector prevalence increases disease threats to wild populations. In 2003, 20% of all deaths of captive TBPs in the United States were due to West Nile virus (WNV) infection. The impact of WNV on human and animal populations in Mexico has been less than in the U.S. possibly due to prior exposure to other flaviviruses. TBPs nest at elevations > 2000m. These high elevation habitats may limit mosquito activity. If mosquito activity is limited, exposure to other flaviviruses that cross-protect against WNV will also be limited. We initiated a TBP health and habitat monitoring program at four nests sites in the Sierra Madres to better define disease concerns in the region. We identified mosquito vectors for WNV, *Culex quinquefasciatus* and *C. tarsalis*, at two sites. Serum samples were collected from 24 TBP chicks and were negative for WNV and St. Louis encephalitis virus. Using a mobile molecular laboratory, *in-situ* field diagnostics were performed on samples collected from a dead chick. The liver and spleen were positive for a non-WNV flavivirus. We were unable to confirm whether this virus contributed to the bird's death.

HIGH PREVALENCE OF EAR CANAL CANCER IN ENDANGERED CATALINA ISLAND FOXES (*Urocyon littoralis catalinae*)

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Abstract

Since 2001, an unusually high number of ceruminous gland carcinomas (CGC) and ceruminous gland adenomas (CGA) (collectively "tumors") have been detected in endangered Santa Catalina (SCA) island foxes (*Urocyon littoralis catalinae*). CGC can have an aggressive clinical course with local invasion or metastasis, and both CGC and CGA can manifest as chronic disease characterized by severe otitis externa and/or fatal sepsis. To determine the prevalence and risk factors for tumors, 357 foxes on SCA, San Nicolas Island, and San Clemente Island were examined and 156 foxes were biopsied for histopathology and sampled for ear mites, bacteria, viruses, and toxins. Tumors were found only in SCA foxes. Among foxes ≥ 4 yr old, 48% had tumors, 2/3 of which were CGC. The most significant condition associated with CGC was severe otitis externa with ceruminous gland hyperplasia, likely stimulated by ear mite infections. These lesions were more severe in SCA foxes than in foxes on the other islands, though ear mite prevalence approached 100% on all islands. No viruses were detected, and no bacterial infections or toxins were significantly associated with tumors. This study disclosed a nearly unprecedented level of cancerous and non-cancerous tumors in a wildlife population. Whether these tumors occur in SCA foxes because of genetic predisposition, or other factors such as ear mites, is under investigation. Treatment of 57 SCA foxes for ear mites resulted in absence of mites and reduced visible inflammation in 36 of 40 study animals recaptured at 6 mo. Histopathology of pre- and post-treatment biopsies is underway.

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ASTROVIRUS-ASSOCIATED DISEASE IN ORPHANED GREY SQUIRRELS (*Sciurus carolinensis*)

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Abstract

Astrovirus was identified in orphaned grey squirrels (*Sciurus carolinensis*) being hand-raised at a wildlife rehabilitation center. A group of 14 squirrels became acutely ill with bloating, depression, nausea, and severe mucoid diarrhea. Serial fecal tests yielded no parasites; cultures from fecal samples, rubber feeding nipples, bowls, and the formula used for feeding revealed no GI pathogens. All affected squirrels were treated with metoclopramide, subcutaneous fluids, trimethoprim-sulfamethoxazole or metronidazole, and simethicone gas drops. Twenty-one percent (3/14) died within 24 hr of onset of signs. The remaining squirrels improved within 4 days and were clinically normal within 10 days. During a post-mortem necropsy, astrovirus particles were found by electron microscopy in samples of intestine from one squirrel, as well as in fecal samples submitted from other affected squirrels. Consensus PCR and sequencing of these fecal samples revealed two distinct novel astroviruses in the genus *Mamastrovirus*, one of which was found in all animals tested. Astroviruses are a family of RNA viruses that have been identified in various mammal species as well as several avian species.[1,3] Human Astrovirus is one of the leading causes of diarrhea in infant humans and turkey astroviruses cause low growth rates in affected turkey poults.[1,3] By inducing an increase in epithelial barrier permeability, astroviruses cause severe mucoid diarrhea in the absence of significant histopathologic changes.[2,4] The clinical signs exhibited by this group of squirrels are similar to those seen in other species, although with a higher mortality rate. To our knowledge, astroviruses have not previously been identified in grey squirrels.

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SMALL VHF-IMPLANTS FOR RADIO-TRACKING REINTRODUCED, FREE-RANGING ORANGUTANS (*Pongo pygmaeus*)

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Abstract

Numerous orangutan (*Pongo pygmaeus*) rehabilitation-reintroduction facilities exist throughout the species' range. Today, some 1200 animals are held in Indonesia alone. The conservation value and impact of these institutions is controversial.[2] With data lacking, an issue repeatedly and unsatisfactorily discussed is the success of reintroduction measures. In the past, radio telemetry has been viewed as unpractical and even dangerous in this species.[1] In order to provide the numerous facilities throughout the orangutan range with a monitoring solution, we developed a small implantable VHF transmitter. The unit is controlled by a very low-power-timer-circuit that allows for a life span of several years. The preprogrammed VHF transmitting schedule (1-7 days/wk and up to 24 hr/day) is activated in the field by the user. The electronic circuit is housed in a CNC engineered, inert ceramic casing, hermetically sealed with specially formulated epoxy glue. A magnetic interface is used to switch the unit into an ultra low-power sleeping mode or start up the transmission schedule. The physical dimensions of the standard implants are 28 mm in diameter and 9 mm in height. To extend the theoretical lifetime of the transmitter a version with higher battery capacity is available which increases the height to 11 mm. The implants weigh 13 g for the standard size and 16 g for the extended size. To track the signal of the implants, a standard tracking receiver and adequate antenna covering the frequency range from 142 to 143 MHz should be used. Following initial trials in a zoo setting, the first implantations were undertaken at the Sepilok Orangutan Rehabilitation Center, Sabah, Malaysia. Units were surgically implanted in a subcutaneous pouch in the dorsal neck area. After placement, a standard 2-layer closure was performed. Initial field tests have demonstrated that these implants greatly facilitate the tracking of released orangutans in the field. With some 600+ and 50+ animals awaiting release in Indonesia and Malaysia respectively, these radio-telemetry implants will be a valuable tool in elucidating the fate of reintroduced orangutans.

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VETERINARY INVOLVEMENT IN THE BORNEAN WILD CATS AND CLOUDED LEOPARD PROJECT

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Abstract

In 2006 The Bornean Wild Cats and Clouded Leopard Project was established in order to provide accurate data on the Bornean wild cats' ecology and biology, and to assist with the conservation management of these species. Borneo's rainforests support five species of wild felids: Sunda clouded leopard (*Neofelis diardi*), marbled cat (*Pardofelis marmorata*), bay cat (*Pardofelis badia*), flat-headed cat (*Prionailurus planiceps*), and leopard cat (*Prionailurus bengalensis*). The Sunda clouded leopard and the marbled cat are considered *Vulnerable* by the World Conservation Union (IUCN).[2] The bay cat and the flat-headed cat are considered *Endangered.* Only the leopard cat is not considered threatened. One of the main threats of the Bornean felines is loss of habitat as a result of deforestation and forest conversion for agricultural use such as oil palm plantations.[3] At present only 52% of the island´s rainforest remains untouched.[5] While the four threatened felids do not inhabit oil palm plantations, the leopard cat is known to use this habitat.[1,4] Other potential threats to the Bornean felines include illegal hunting of the cats and their prey, and diseases transmitted from feral cats and dogs. The veterinary role in this project includes the safe chemical immobilization of the wild cats, data collection on the hematology and biochemistry of the different species, the development of safer immobilization protocols, and documentation of health parameters of the wild cats.

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BROWN HYENA (*Hyena brunnea*) ECOLOGY, ANESTHESIA AND PRELIMINARY OPHTHALMIC EVALUATION IN NAMIBIA, AFRICA

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Abstract

There are four species of hyena; the brown (*Hyaena brunnea*), spotted (*Croctua croctua*), striped (*Hyaena hyaena*) and the Aardwolf (*Proteles cristata*). The brown hyena is one of the largest mammalian scavengers in Africa. Males weigh 40.2 +/- 3.0 kg, and the females weigh 37.6 +/- 3.4 kg. They have powerful jaws, a long, shaggy coat, and powerful forelimbs and shoulders. The rear limbs are relatively weak in comparison. The brown hyena is a nocturnal, solitary hunter, and travels 25 – 40 km per night in search of food. They live in small clans composed of one male, one female and their offspring. They communicate their territories through anal secretions pasted on vegetation. Though they are predominantly scavengers, they actively kill and consume Cape fur seal pups (*Arctocephalus pusillus*) and consume Tsama and Gemsbok cucumbers.

There are an estimated 5,000-8,000 brown hyenas in the wild; all populations are located in central, western, and southern Africa. The estimated Namibian population is between 800 and 1,000 individuals. The brown hyena is considered the apex predator along the Skeleton Coast of Namibia; a cool desert environment. Diamond mining, vehicular trauma and human encroachment threaten existing populations of the hyena.

In May of 2009, as part of the Brown Hyena Research Project, four of seven attempts at immobilizing brown hyenas over a 17 day period were successful utilizing a combination of 80 mg ketamine hydrochloride and 1.4 mg medetomidine hydrochloride delivered by remote injection (Telinject, Inc. Agua Dulce, California 91350 USA). Clinical effects were noted within 3 min and all four animals became recumbent within an average of 7 min. All four animals were female. Clinical exam and anesthetic monitoring included physical examination, dental and oropharyngeal exam, age determination, gender determination, pregnancy status, pulse oximetry, stethoscopy, temperature, phlebotomy for banked sera samples, skin biopsy, global positioning satellite (GPS) collar placement, and photo identification. An initial select ophthalmic examination included direct ophthalmoscopy, Schirmer® tear testing, Schiotz tonometry, and flourescin staining of the cornea. One individual demonstrated asteroid hyalosis and punctate corneal ulcers O.U.

All four animals were stable throughout the procedure and were reversed with 7 mg atipamezole hydrochloride im. Recovery occurred within 5 min on each animal and all four animals recovered without complication. GPS monitoring has continued to document the home ranges of each individual.

Future endeavors include evaluation of viral titers, sera chemistries, fecal hormones, internal and external parasite examination, and impact of local domestic animals on the ecology of the brown hyena.

Numerous challenges limit the successful darting of the brown hyena. The remote isolated location, government restrictions, weather, venomous animals, and a lack of infrastructure and supplies and the solitary, nocturnal nature of the hyena present nearly insurmountable challenges. These challenges inhibit a true assessment of the health and status of the brown hyena along the Skeleton Coast of Namibia.

CONSERVACIÓN DE LOS GATOS DE PATAS NEGRAS (*Felis nigripes*) Y LA PREVALENCIA DE ENFERMEDADES INFECCIOSAS EN CARNÍVOROS SIMPÁTRICOS EN SUDÁFRICA

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Resumen

El gato de patas negras (*Felis nigripes*) es un felino pequeño (~2 kg) con un rango limitado en África del Sur. Esta especie está incluida en el Apéndice 1 del CITES, listada como En Peligro de Extinción por el Servicio de Pesca y Vida Silvestre de los EUA, y se la ha colocado como la especie felina más vulnerable entre aquellas de la parte Sub-Sahara por el Grupo Especialista en Felinos de la Unión para la Conservación de la Naturaleza (IUCN, por sus siglas en inglés). Este proyecto es parte de una iniciativa mayor de conservación para entender la ecología, la genética, la salud y la biología reproductiva del gato de patas negras en África del Sur. De 2004-2009, el Grupo de Trabajo del Gato de Patas Negras capturó 18 gatos de patas negras de vida silvestre en dos sitios de estudio. Se capturaron seis gatos y se obtuvieron un total de 26 muestras de suero. También se colectaron muestras de suero (n = 87) de pequeños carnívoros que comparten con los gatos de patas negras tanto el territorio como las presas base y las oportunidades de exposición a las enfermedades, incluyendo un gato africano silvestre, tres gatos domésticos dos perros domésticos, seis zorros del Cabo, cinco zorros orejas de murciélago, tres chacales de espalda negra, siete AARDWOLVES y 34 mangostas amarillas. La evidencia serológica de exposición a los patógenos virales que se normalmente afectan canidos y félidos fue baja para todos los virus, excepto para el virus del distemper canino (CDV). La especie con la seroprevalencia más alta de CDV fue la mangosta amarilla la cual demostró una disminución dramática en la seroprevalencia de 2005 a 2009. En la actualidad se llevan a cabo algunos intentos para identificar el virus del distemper canino de los especímenes biológicos usando técnicas de diagnóstico molecular, para determinar si el virus está presente en portadores asintomáticos. Esta información ayudará a comprender mejor la epidemiología del virus del distemper canino y su impacto potencial en las poblaciones de pequeños carnívoros.

PIÁN, ¿UNA ZOONOSIS EMERGENTE EN GORILAS?

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Resumen

El pián (*Treponema pallidum* sbsp. *pertenue*), también conocido como frambesia es una enfermedad tropical descuidada de los humanos que puede estar presente en varias poblaciones de gorilas de tierras bajas del Oeste (*Gorilla gorilla gorilla*) en la República del Congo y en Gabón. El pián causa enfermedad severa en la piel y deformidades esqueléticas en humanos, lo cual puede limitar la movilidad. En el Parque Nacional Odzala en la República del Congo, se observaron gorilas con lesiones macroscópicas que son similares al pián en humanos; en esta zona el síndrome aparentemente limitó el éxito reproductivo en los gorilas machos adultos.[1]

La evidencia de que existen enfermedades causadas por treponemas en los primates no humanos, particularmente en los gorilas (*Gorilla gorilla gorilla*) y los chimpancés (*Pan troglodytes troglodytes*), se ha basado principalmente en la patología esquelética[2]; sin embargo, Karesh (2000) muestreó 4 gorilas de tierras bajas del Oeste en el Parc National d'Odzala-Kokoua, los cuales fueron positivos a los anticuerpos anti- treponemas [3.] Las enfermedades por treponemas son morfológicamente idénticas y las 4 enfermedades (pián, bejel, pinta, sífilis) inducen la reactividad del suero en pruebas serológicas estándar para la sífilis; por ello, la diferenciación del agente causal basada solo en la serología es problemática. Se encontró que un aislado de treponema de un babuino silvestre (especie no identificada) estaba relacionado de manera estrecha con el pián de los humanos.[4] La infección experimental de humanos con este aislado causó infecciones activas, provocando cuestionamientos sobre si los primates pudieran fungir como reservorios para los patógenos zoonóticos tipo treponemas; deben completarse los estudios para descartar el comercio de carne selvática como una fuente potencial de transmisión.[5] Un segundo estudio encontró que la cepa del simio del babuino silvestre era filogenéticamente no distinguible del pián humano.[6] Se requieren estudios moleculares adicionales para diferenciar la transmisión cruzada entre especies de grandes simios versus la coevolución del patógeno.

Se llevó a cabo un programa piloto de vigilancia en el Parque Nacional Langoue Bai, Ivindo, en Gabón, mostrando una tasa de prevalencia del 50 % de los gorilas adultos, ajustándose a la definición de caso para el síndrome parecido al pián. Una definición de caso para el pián en humanos es aquel que vive en un área endémica y presenta uno ó más de los siguientes signos: úlcera con costra, papilomas, e hiperqueratosis palmar / plantar.[7] El pián es endémico tanto en Gabón como en otros países africanos del Oeste y del centro.[8] Otras enfermedades dermatológicas tropicales como la úlcera Buruli pueden tener lesiones similares. Se observó algún tipo de dermatopatía en 16 /18 gorilas adultos. No hubo lesiones visibles en la poblaciones

juveniles y de infantes (n=10). A pesar de que se dispone de una cura efectiva para las enfermedades por treponemas, la geografía del Langoue Bai haría difícil la intervención si la etiología de la enfermedad fuera en realidad una treponema. La reinfección sería altamente probable aún si se intentara la intervención.

Además de colectar información piloto, este estudio requirió el entrenamiento de los trabajadores de campo Gaboneses en el acopio de los datos para el monitoreo de la salud de los gorilas.

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CONSERVACIÓN EN EL INTERIOR

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Resumen

Recuperación Árida es una iniciativa única de conservación enfocada en el interior del Sur de Australia, y primariamente está apoyada por la Billiton BHP (Presa Olímpica), Departamento del Sur de Australia para el Ambiente y Patrimonio, la Universidad de Adelaida y la comunidad local.[1] Un punto focal de esta iniciativa es la Reserva de la Recuperación Árida a prueba de animales ferales, la cual cubre un área total de 123 km^2, de los cuales 60 km^2 están libres de gatos ferales, zorros y conejos. Estas especies fueron completamente retiradas de la reserva en el 2001 mediante la combinación del veneno 1080, fumigación de conejeras, trampeo y disparos.[1] La remoción de estas especies ferales ha permitido la regeneración de las plantas nativas y el restablecimiento de las poblaciones nativas de mamíferos dentro de la reserva. Las especies de mamíferos localmente extintas, y en peligro de extinción, incluyendo la rata mayor de nido de madera (*Leporillus conditor*), bettong cavador (*Bettongia lesueur*), bilby mayor (*Macrotis lagotis*) y el bandicoot listado occidental (*Perameles bougainville*), han sido también reintroducidas de manera exitosa en la reserva. Existe un control progresivo y remoción de los gatos y los zorros en un área de 200 km^2 sin cercas adyacente a la reserva, para que las poblaciones silvestres de bilbys puedan establecerse en esta zona.

Existen múltiples proyectos de monitoreo en curso llevados a cabo dentro y alrededor de la Reserva de Recuperación Árida. Las poblaciones de los bettongs cavadores, de los bilbys mayores, de las ratas de nido de madera y de los bandicoots listados occidentales se monitorean a través de secciones trimestrales de caminos y de trampeo anual por jaulas. Los caminos se barren un día antes del conteo con una cadena arrastrada debajo de una bicicleta. Todos los caminos que cruzan sobre esta línea dragada se cuentan al día siguiente. A cualquier especie reintroducida que se atrapa se le registra el peso corporal, sexo, estado reproductivo y longitud, además de asignarle un número de identificación único a través de un microchip o una etiqueta en la oreja. También se registra el grosor de la cola en el caso de los bettongs cavadores. Toda la información del trampeo se captura en una base de datos. Los bilbys y los bettongs cavadores se monitorean anualmente en cuanto a actividad, tamaño y co-ocupantes. De manera similar, los nidos de las ratas mayores de nido de madera se monitorean dos veces al año. El número de senderos y la presencia de huellas frescas son solo algunos parámetros usados para determinar la actividad de cada madriguera y nido.

El establecimiento exitoso de estas poblaciones en desarrollo de las cuatro especies reintroducidas ha sido confirmado por estos métodos de monitoreo regular.

La investigación también es un componente principal de la Recuperación Árida. Las investigaciones actuales incluyen el papel de los dingos en el control de los números de gatos y zorros, mediante el estudio de las interacciones entre los dingos, los gatos y los zorros en un encierro con vallas de 37 km^2 utilizando collares GPS en estas especies. Una entrada de una sola dirección se está diseñando y probando también para permitir a los bilbys mayores y a los bettongs cavadores dispersarse de forma natural dentro de las áreas donde actualmente no se encuentran habitando. Esto podría vencer la barrera no natural para la dispersión formada por la valla que puede ocasionar una sobrepoblación. Se están probando diferentes diseños de puertas en los gatos ferales para asegurar que no puedan entrar. También hay más proyectos planeados para ayudar a comprender la ecología y el estado de salud de las especies reintroducidas. Las prioridades de investigación incluyen la comparación de la genética de la reserva animal fundadora de las especies reintroducidas con la de la población actual, para investigar la diversidad genética dentro de estas especies. Se han colectado muestras de la oreja de cada especie durante las sesiones regulares de trampeo, y estas han sido almacenadas para valoración genética. Otra prioridad de investigación involucra el impacto de las minas en las especies reintroducidas. Esto es importante ya que la Reserva de Recuperación Árida se localiza cerca del sitio de la mina de la Presa Olímpica BHP Billiton, la cual es en la actualidad la mina subterránea más grande en el hemisferio sureste.[2] Las minas de la Presa Olímpica contienen uranio, cobre, oro y plata, y mientras no exista evidencia que sugiera que las especies reintroducidas están mostrando signos de intoxicación por metales pesados, es importante investigar si la proximidad la sito mina es una amenaza para la sobrevivencia a largo plazo de estas especies, y establecer alguna información basal antes de la expansión planeada de la mina Presa Olímpica.

Los objetivos primordiales del proyecto que investiga los impactos de la mina en las especies reintroducidas, incluyen una revisión de la literatura sobre la intoxicación por metales pesados en los mamíferos y la identificación de los principales signos clínicos tanto inmediatos como a largo plazo, asociados con la exposición a diferentes niveles de contaminación por metales pesados. La revisión de la literatura reveló que los signos de la intoxicación por metales pesados reportados en mamíferos terrestres incluyen disminución del hematocrito y de los niveles de globulina, cambios patológicos en la morfología celular de los glóbulos rojos, cambios en los niveles urea /creatinina, niveles incrementados de metalotioneína, cambios en la enzimas hepáticas, disminución de pesos corporales y de órganos, cambios histopatológicos en órganos y aumento en la frecuencia de aberraciones en los cromosomas. La revisión de la literatura se utilizó después para desarrollar un estudio piloto que involucraba la colección de sangre de los bettongs cavadores, y llevar a cabo las pruebas de mayor costo-beneficio como la evaluación morfológica de los frotes sanguíneos usando la microscopia luminosa. El estudio piloto permitió el desarrollo de un protocolo para la colección de sangre de la vena lateral de la cola de los bettongs cavadores. Los frotes sanguíneos evaluados del estudio piloto no mostraron anormalidades significativas en la morfología celular de los eritrocitos ni en los conteos diferenciales de las células blancas. El estudio también ha revelado la falta de investigación para establecer los rangos normales de referencia para los valores hematológicos de los bettongs cavadores. El estudio piloto formará la base de las investigaciones posteriores sobre las cargas de metales pesados en la fauna reintroducida dentro de la reserva, así como ayudar a establecer la base de datos inicial.

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PREVALENCIA DE ANTICUERPOS CONTRA RABIA EN COMUNIDADES DE MUERCIÉLAGOS NEOTROPICALES EN PAISAJES FRAGMENTADOS EN PUEBLA, MEXICO

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Resumen

La pérdida del hábitat y la fragmentación han favorecido la pérdida de la biodiversidad, cambios en las relaciones de especies y cambios en la frecuencia de las zoonosis emergentes y reemergentes, tales como la rabia. El virus de la rabia ha sido aislado de diferentes especies de murciélagos; sin embargo, la historia natural y la forma en que el virus se mantiene en las comunidades de murciélagos siguen siendo desconocidas.

El objetivo de este estudio fue descubrir los efectos de la pérdida del hábitat y la fragmentación sobre la prevalencia de la rabia en las comunidades de murciélagos en diferentes tipos de hábitats en paisajes fragmentados en Puebla, México.

Comparamos la diversidad de murciélagos y la prevalencia de la infección en tres tipos de hábitat (interior, bordes y potreros) dentro de cuatro tipos de vegetación (bosque, acahual maduro, acahual joven y praderas) en seis fragmentos que variaban de tamaño y aislamiento. Obtuvimos muestras de sangre de 194 murciélagos pertenecientes a 15 especies y 12 géneros. La diversidad de especies fue mayor en las praderas (0.89 índice de Simpson), seguida de las áreas boscosas (0.87) y los bordes (0.82).*Sturnira lilum* fue la especie capturada más común en las áreas de bosque (28%) y los bordes (38%), mientras que *Sturnira ludovici* dominó en las praderas (19%). Las muestras de sangre se analizaron en el Centro Nacional de Microbiología Veterinaria, INIFAP, y se realizó la prueba inmunoenzimática ELI-Rab. Un total de 20 % de los murciélagos capturados fue positivo a los anticuerpos contra la rabia. La prevalencia de anticuerpos en los potreros fue de 27 %, seguida por el interior (22%) y los bordes (14%) sin significancia estadística ($X^2 = 1.94$ $d.f.=2$, $p > 0.05$). La prevalencia de anticuerpos contra la rabia en el tipo de vegetación acahual maduro fue del 34 %, seguida por el acahual joven (17%) y el bosque (8%) ($X^2 = 9.9$ $d.f.= 2$, $p<0.05$). La alta seroprevalencia indica que el virus de la rabia es endémico en estas comunidades de murciélagos y que estas especies son refractarias o capaces de recuperarse de la infección del virus de la rabia. Se requieren estudios posteriores para comprender el papel de cada especie en el mantenimiento del virus. En esta escala espacial local, nuestro estudio concluye que el ecosistema es altamente homogéneo. Se justifican estudios posteriores para conocer los efectos de la pérdida del hábitat y la fragmentación sobre las comunidades de murciélagos y sobre la dinámica de la infección en las áreas tropicales donde se establecen las actividades de agricultura.

ASOCIACIÓN ENTRE LAS SEROVARIEDADES DE LEPTOSPIRA EN ROEDORES NATIVOS Y EXÓTICOS DE LA ISLA DE COZUMEL, MÉXICO

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Resumen

Los ecosistemas de las islas oceánicas se usan como modelos para los estudios ecológicos, debido a que son sensibles a las actividades humanas y especialmente vulnerables a la introducción de especies exóticas y de patógenos.[1,2] *Leptospira* fue seleccionada como modelo para identificar las posibles interacciones patógeno-hospedero basadas en las relaciones reconocidas serovariedad-hospedero, específicamente al buscar en las relaciones entre los ratones silvestres nativos (*Oryzomys couesi cozumelae*) y poblaciones de roedores introducidos (*Mus musculus* and *Rattus rattus*), y la seroprevalencia (SP) de seis serovariedades de *Leptospira* (Australis, Ballum, Canicola, Autumnalis, Icterohaemorrhagiae and Hardjoprajitno) en la Isla mexicana de Cozumel. Las muestras de suero (*Oryzomys* n = 66, *Mus* n = 156 y *Rattus* n = 57) se analizaron con la prueba de microaglutinación (MAT). La más seroprevalente (todas las especies juntas) con títulos promedio MAT ≥ 1:100, fueron: Australis (73%), Canicola (66.5%) y Ballum (42%). Icterohaemorrhagiae y Autumnalis tuvieron una SP < 26% con títulos MAT promedio < 1:50 y se asumió que eran reacciones no específicas. Todas las pruebas fueron negativas para Hardjoprajitno. Los SP de Australis SP fluctuaron entre el 67% al 75% entre las tres especies y fueron significativamente diferentes por la prueba de chi-cuadrada ($p > 0.05$). Se observaron diferencias significativas para Canicola, donde *Oryzomys* y *Mus* (especies de ratones) tuvieron SP > 71% mientras que *Rattus* tuvo 14% ($p \leq 0.05$). De forma similar, para las especies de ratones los SP de Ballum fluctuaron entre el 39% al 49%, mientras que *Rattus* tuvo un SP de 23% ($p \leq 0.05$). Se usó la regresión logística simple para explorar las asociaciones entre los SP y las características de los roedores (especie, captura, área, edad y sexo). Las seroprevalencias observadas sugieren que los roedores introducidos o nativos, sirven como reservorio para la *Leptospira* spp. patogénica. Los resultados para las serovariedades Australis y Ballum indican una relación de serovariedad adaptada al hospedero (SP > 50% y título promedio > 1:100), la primera serovariedad con las tres especies, mientras que para Ballum solo con ratones. Los SP de Canicola fueron mayormente encontrados en ambas especies de ratones e ilustran la serovariedad hospedero- accidental (SP > 60% y el título promedio más alto), y estos SP de serovariedad pueden ser la consecuencia del comportamiento de cada especie de roedor y su interacción con perros y mapaches en la Isla. Los SP fueron mayores en las áreas urbanas, y menores en las áreas naturales. En Cozumel, los roedores pueden jugar un papel en el riesgo de infección para otros mamíferos nativos y domésticos, o para los humanos. La vigilancia, el aislamiento y la caracterización molecular de *Leptospira* spp. deben llevarse a cabo para incrementar la

comprensión de la serovariedad y las relaciones con los hospederos, y el riesgo relacionado en la Isla de Cozumel.

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CONTROL DE LA PESTE SELVÁTICA EN PERRITOS DE LAS PRADERAS: ÚLTIMOS AVANCES

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Resumen

La peste selvática, enfermedad zoonótica causada por la bacteria *Yersinia pestis* (Fam. Enterobacteriaceae), llegó a los Estados Unidos de América hace más de 100 años.[1,4] Los perritos de las praderas (*Cynomys* spp.) y otras ardillas terrestres actúan como hospedadores epizoóticos sufriendo altas tasas de mortalidad, pero los hospedadores enzoóticos aún no han sido identificados en muchos ecosistemas.[1-3] Los perritos de las praderas son especies clave en los ecosistemas de praderas, y su disminución en número o distribución afecta a otras especies, tales como el hurón de patas negras (*Mustela nigripes*).[5] El control de vectores, aún siendo útil para el control de brotes epizoóticos, es costoso y a menudo se emplea demasiado tarde para ser efectivo. La vacunación oral de los perritos de las praderas podría representar una alternativa factible. Inoculaciones experimentales en el laboratorio demostraron que la vacunación de perritos de las praderas con un poxvirus recombinante del mapache que expresa antígenos de la bacteria, proporciona protección frente a dosis de *Y. pestis* que simulan exposición en el medio natural.[6] Antes de distribuir la vacuna en el campo, se ha de seleccionar un cebo que sea atractivo para los animales y resistente a condiciones ambientales, además de un biomarcador que permita evaluar su consumo. Estudios recientes en el laboratorio determinaron que el sabor preferido por los animales es la mantequilla de cacahuete y que el consumo de cebos elaborados con la vacuna proporciona protección frente a la inoculación con *Y. pestis*. También se demostró que la rodamina B, incorporada en los cebos a una concentración de 0.25%, es un biomarcador efectivo en perritos de las praderas, proporcionando un método simple y fiable para controlar la ingestión de cebos en futuros ensayos en el campo.

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CONOCIENDO AL PLOMO: EL ECOSISTEMA Y LOS ASPECTOS POLÍTICOS

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Resumen

Durante mucho tiempo la sociedad ha conocido la intoxicación por plomo (Pb) en los humanos,[21,29] pero esta intoxicación en los animales está mucho menos documentada. No fue sino hasta finales del siglo XIX que aparecieron los primeros reportes confiables de la intoxicación en los animales domésticos y silvestres. [8,32] Durante la mayor parte del siglo XX el plomo se comercializó como un material maravilloso con muchos usos. Requirió esfuerzos heroicos de médicos como Alice Hamilton y Herbert Needleman y de investigadores como Clair Patterson erigir los fundamentos científicos necesarios para implementar el cambio político significativo. A finales de los 1970´s el plomo se había eliminado de la mayoría de las gasolinas y de las pinturas de casa y el nivel promedio del plomo sanguíneo empezó a disminuir en la población de los EUA.[2] Las regulaciones subsecuentes también ocasionaron restricciones modestas sobre otros usos del plomo incluyendo soldaduras, glaseado de cerámica y en varios otros productos, en un esfuerzo por proteger la salud humana. Pero muchos productos que contienen plomo continúan en el mercado. Después de una disminución inicial en el uso del plomo en los EUA a finales de los 1970´s, la cantidad de plomo minado, fundido, fabricado en productos y comercializado en los EUA, ha permanecido constante desde principios de los 1980´s hasta la fecha.[31] Actualmente el principal uso del plomo en los EUA y en la mayoría de los países desarrollados es en las pilas (baterías) de almacenamiento ácido de plomo. Es difícil encontrar números precisos, pero a grandes rasgos 8% del uso del plomo va para el equipo de pesca, balas y tiros para armas de fuego.[3] Cabe destacar que aunque ha habido un declive gradual en las ventas de licencias para cazar y pescar en los EUA en los últimos 30 años, ha habido un incremento dramático en la participación de deportes de tiro (tiro al blanco, trampa, tiro al plato, etc).[33] Estas actividades siguen depositando muchos miles de toneladas de plomo en el ambiente cada año.[30,33] Las minas, la fundición, la fabricación y el reciclado también contribuyen de manera significativa a la contaminación medioambiental. Este es un problema de mayor significado en muchos países en desarrollo.[4,9,33]

La literatura veterinaria contiene abundantes reportes de caso de envenenamiento por plomo en especies domésticas, pero existen pocos estudios epidemiológicos a gran escala.[18] En el reino de la vida silvestre, se han documentado mortalidades significativas en aves acuáticas por más de 100 años,[8] pero fue la amenaza del envenenamiento con plomo en las águilas calvas (*Haliaeetus leucocephalus*) la que provocó la implementación de tiros no tóxicos para la cacería de aves acuáticas en los EUA a finales de los 1980´s.[1,33] En los EUA casi todas las balas y tiros usados para cazar aves de ornato y mamíferos en tierras altas (así como para los deportes de tiro) aún

son hechas de plomo.[33] Aún hoy día, grandes números de águilas, somorgujos, aves acuáticas, rapaces y muchas otras especies mueren anualmente al ingerir el plomo usado en las actividades de cacería y de pesca.[11,17,22,24,25,28,33] Para un carroñero en peligro de extinción, el Cóndor de California (*Gymnogyps californianus*), el envenenamiento por plomo ha sido demostrado como el factor principal de mortalidad que limita de manera significativa el éxito de los esfuerzos de reintroducción.[33]

A pesar de que el envenenamiento clínico por plomo aún es una enfermedad importante en la medicina de humanos, una gran cantidad de investigación reciente se ha enfocado en los efectos subletales, crónicos del plomo. Se han documentado los efectos clínicos significativos sobre muchos sistemas, incluyendo la presión sanguínea y el sistema cardiovascular, el sistema reproductivo, la función renal, los sistemas hematopoyético e inmune, y los sistemas nerviosos central y periférico, incluyendo los efectos perjudiciales sobre el aprendizaje, el control del comportamiento agresivo, la sensación y el control motor fino, etc.[10,23,26]

No obstante, se ha realizado relativamente poca investigación sobre los efectos subletales en los vertebrados no humanos, pero los estudios que sí existen documentan efectos similares en una gran variedad de vertebrados incluidos los mamíferos, las aves, los reptiles, los anfibios y los peces.[13] Se han reportado deficiencias en las habilidades cognoscitivas en niños con concentraciones sanguíneas de plomo tan bajas como 5 μg/dL.[15] Otro estudio encontró que un incremento neto de 1 μg/dL en el promedio de vida de los niveles sanguíneos de plomo se correlacionaba con una pérdida de 0.46 puntos IQ.[7] Los efectos cognoscitivos del plomo subletal están siendo estudiados en los animales silvestres. En las crías de gaviotas arenque (*Larus argentatus*) se observaron los efectos de la dosis de plomo aplicada en acetato para producir concentraciones de plomo en las plumas equivalentes a los que se encuentran en gaviotas silvestres, sobre la locomoción, búsqueda de alimentos, alimentación, aprendizaje en las rutinas, termorregulación y reconocimiento individual.[5] Diversos estudios han encontrado una asociación entre la intoxicación subclínica por plomo y los comportamientos delincuentes, antisociales y agresivos en los humanos.[19,20,27] De forma similar, se ha documentado el desarrollo de comportamientos agresivos en perros y gatos domésticos que tienen niveles sanguíneos elevados de plomo, así como en aves canoras expuestas a metales pesados.[12,14,16] Las tortugas que recién eclosionan expuestas a concentraciones medioambientales relevantes de plomo mostraron cambios fisiológicos y conductuales que podrían reducir dramáticamente su sobrevivencia en la naturaleza.[6] La exposición ambiental a bajos niveles de plomo podría contribuir a la mortalidad de animales silvestres dificultando los complejos procesos mentales y comportamientos sociales que se requieren para la reproducción, la migración y muchas otras actividades.

La mayoría de las personas no tienen que convencerse que el plomo es tóxico, pero ha sido difícil modificar este entendimiento hacia una política convincente e integrada. Para proteger a los somorgujos comunes de la intoxicación por plomo, se han realizado esfuerzos educativos y legislados por grupos de protección en varios estados para alentar a los pescadores que cambien al equipo de pesca no tóxico. Al mismo tiempo, otros grupos trabajan arduamente para educar al público y a quienes formulan las políticas sobre los riesgos a las aves predadoras y a los cisnes por la ingestión de plomo. Los defensores de la salud de los niños y las agencias federales y

estatales gastan millones de dólares cada año para educar al público sobre los daños progresivos de la exposición a la pintura con plomo en las casas antiguas. Los grupos de seguridad al consumidor intentan acopiar información y alertas de los peligros potenciales del plomo en los juguetes, medicinas tradicionales y alimentos y cosméticos importados. Las agencias de salud ocupacional con frecuencia tratan problemas de exposición de los trabajadores al plomo en las industrias mineras, de fabricación y reciclado, así como con segmentos de la industria de la construcción. Como sociedad, parece que hemos dividido tanto nuestro conocimiento sobre el plomo como los intentos en la educación y la regulación. No es común que los veterinarios, los médicos, los profesionales de la salud pública, los especialistas de la salud ocupacional y otras instancias interesadas se reúnan para compartir el conocimiento, e intenten encontrar soluciones comunes para los múltiples problemas asociados con la intoxicación por plomo.

Aún existe una gran cantidad de trabajo que requiere hacerse para proteger a los humanos y otros animales del riesgo del envenenamiento por plomo. Los veterinarios de zoológico y vida silvestre pueden desempeñar un papel crucial en el acopio de la información y en la realización de estudios que promuevan el cambio en las políticas. La investigación futura sobre la intoxicación por plomo debería considerar los siguientes 4 apartados:

1. Los efectos del envenenamiento por plomo son similares entre las especies de vertebrados y es razonable extrapolar (cautelosamente) entre taxones.
2. El envenenamiento clínico por plomo está sub-reportado tanto en animales domésticos como silvestres, y muchos de los efectos subclínicos del plomo con frecuencia no se toman en cuenta.
3. Un impedimento principal para las iniciativas políticas recientes es la separación disciplinaria que existe entre los grupos que investigan los asuntos relacionados con el envenenamiento por plomo.
4. Mientras que el concepto del uso de animales como centinelas de la salud humana no es nuevo para la medicina de la conservación, los profesionales de la vida silvestre pueden no darse cuenta de la riqueza de información que puede obtenerse al hacer un abordaje opuesto y utilizar a los humanos como indicadores o centinelas para la salud animal y medioambiental, particularmente en el área de los efectos subletales.

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CAZANDO VIRUS: AVENTURAS DE UN VAQUERO DE ENFERMEDADES INFECCIOSAS

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Biografía

Joseph B. McCormick, MD es un decano del campus Brownsville de la Universidad de Texas, Escuela de Salud Pública. Se crió en una granja en Indiana. Después de graduarse cum laude de la Universidad del Sur de Florida con especialidades en química y en matemáticas, asistió a la Alianza Francesa y a la Universidad Free en Bruselas, para prepararse para enseñar ciencias y matemáticas en francés en una escuela secundaria en el Congo. En el hospital local de esa región, tuvo contacto con la medicina, particularmente la medicina tropical. Se inscribió a la Escuela Médica Duke en 1967, graduándose en 1971 con una Maestría intercalada de la Escuela de Salud Pública de Harvard (1970). Su internado y residencia los llevó a cabo en el Hospital Infantil de Philadelphia teniendo como asesor al Dr. C. Everett Koop. En 1974 se convirtió en Oficial del Servicio de Inteligencia Epidémica (EIS, por sus siglas en inglés) en el CDC, y un investigador en Medicina Preventiva. Fue consultor en PAHO /CDC para el gobierno Brasileño durante los extensos brotes de meningitis de 1974/6.

En 1977 viajó a África del Oeste para fundar el Proyecto de Investigación del CDC de la fiebre de Lassa en Sierra Leona, donde recibió una llamada de emergencia para unirse al equipo de investigación de la primera epidemia del Ébola en 1976 y una vez más en 1979. En Sierra Leona condujo estudios extensos y determinantes sobre la epidemiología y el tratamiento de la fiebre hemorrágica de Lassa, publicando un artículo histórico en el New England Journal of Medicine sobre el tratamiento antiviral efectivo para esta enfermedad. Regresó a Atlanta en 1979 y se convirtió en Jefe de la Rama de Patógenos Especiales, División de Enfermedades Virales en el CDC, dirigiendo laboratorios de Bioseguridad nivel 4 por 9 años. Se involucró en el SIDA y dirigió el equipo original que realizó la primera investigación sobre esta enfermedad en África, y estableció el Proyecto SIDA en Kinshasa, Zaire, para después conducir el Proyecto Retro-Ci en Abidján, Costa de Marfil. Ha sido co-autor de una gran cantidad de artículos en las revistas más importantes, incluyendo Science, y estableció un punto clave en la historia natural de la infección por el VIH en África, muestreando especímenes que guardó en su laboratorio del brote de Ébola de 1976, del cual se aisló el virus VIH más antiguo. En 1983 identificó el virus que causa la Fiebre Hemorrágica con Síndrome Renal (Hantavirus) en su laboratorio en el CDC. Posteriormente, fue pionero en el trabajo de la epidemiología y la virología del Hantavirus, virus Lassa y virus del Ébola.

En 1993 se convirtió en el Presidente del Departamento de Ciencias de la Salud Comunitaria en la Escuela Médica de la Universidad Aga Khan (AKU) donde fundó un programa de

epidemiología, parecido a los Programas de Entrenamiento de Epidemiología de Campo del CDC, y un grado de Maestría en Epidemiología. El grupo de profesores y estudiantes de este periodo, ha publicado más de 45 artículos. En 1997 se mudó a Francia donde fundó los programas de epidemiología para el Instituto Pasteur y para Aventis Pasteur. Regresó a los EUA en 2001 para comenzar un nuevo campus regional de la Escuela de Salud Pública de Houston UT en Brownsville, Texas, donde es un decano regional y profesor de epidemiología con título James H. Steele. Sus reconocimientos incluyen la Medalla del Servicio Meritorio USPHS, y galardones humanitarios del Colegio del Sur de la Florida y de la Escuela Médica de la Universidad de Duke, y el premio Amigo de la Salud Pública del DSHS de Texas. El Dr. McCormick tiene en su haber más de 220 publicaciones científicas con co- autores de más de 20 diferentes países. Ha actuado como revisor de muchas revistas, y ha aparecido en programas de televisión, periódicos y revistas, además de que se le menciona en varios libros para lectores laicos (ej: The Coming Plague, The Hot Zone). Junto con su esposa, Sue Fisher-Hoch él es co-autor de una versión popular (Level 4. Virus Hunters of the CDC) de sus aventuras, la cual fue traducida a siete idiomas, y que ha sido reeditada en pasta dura y pasta blanda. Es un consumado pianista amateur, y disfruta las actividades al aire libre como correr, el excursionismo y esquiar, entre otras.

MÁS ALLÁ DE LAS CERCAS: OPCIONES POLITICAS PARA LA BIODIVERSIDAD, SUSTENTOS Y MANEJO DE ENFERMEDADES TRASLINDES EN ÁFRICADEL SUR

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Resumen

África del Sur tiene una fracción desproporcionadamente elevada de biodiversidad global, la cual se distribuye a lo largo del rango de ecosistemas áridos y semiáridos.

Se han identificado trece Áreas de Conservación Trasfonteriza (TFCAs, por sus siglas en inglés) potenciales y existentes en esta región, muchas rodeando parques nacionales, reservas cinegéticas, áreas de caza y áreas de protección arraigadas dentro de una matriz de tierra regidas por la tenencia comunal tradicional.[4]

Las TFCA´s existentes y propuestas cubren más de 1,200,000 km^2 e incluyen dentro de sus fronteras muchas áreas de conservación de biodiversidad de la más alta prioridad del África sub-Sahara.[4]

AHEAD (Salud Animal y Humana para el Medioambiente y el Desarrollo, por sus siglas en inglés) es un programa de la Sociedad de Conservación de la Vida Silvestre (WCS, por sus siglas en inglés), y sus socios, enfocada en problemas que enfrenta la conservación de la biodiversidad y el desarrollo en tales paisajes traslindes de esas proporciones desde la perspectiva críticamente importante de las conexiones entre la salud de la vida silvestre, la salud de los animales domésticos, así como la salud humana y los sustentos.[3] Un área actual de enfoque es el Área Trasfronteriza Kavango-Zambezi (TFCA KAZA) en el borde de lo que tal vez se está convirtiendo en el paisaje orientado a la conservación más grande del mundo. El desarrollo de las TFCAs para la posterior conservación de la biodiversidad y desarrollo sustentable a través de la armonización del manejo de los recursos naturales traslindes, es una prioridad para la SADC (la Comunidad de Desarrollo de África del Sur, por sus siglas en inglés) y los cinco países que rodean KAZA: Angola, Bostwana, Namibia, Zambia y Zimbabwe. Se ha llegado al acuerdo de crear un área trasfronteriza que incluye aproximadamente 400, 000 km² y que rodea más de 70 parque nacionales, reservas cinegéticas, áreas de conservación comunitarias y áreas de manejo deportivas. El área contiene la población contigua más grande de elefantes (aproximadamente 250,000) en el continente e incluirá, por ejemplo, el Parque Nacional Chobe, Caprivi Strip, el Delta Okavango (el sitio Ramsar más grande en el mundo) y las Cataratas de Victoria (Patrimonio Mundial).

El impulsor económico principal detrás de la creación de las TFCAs como KAZA es el turismo

basado en la naturaleza, el cual busca maximizar las devoluciones de tierras marginales en un sector donde África del Sur disfruta de una ventaja comparativa global. [1,2] De hecho, el turismo basado en la naturaleza contribuye ahora aproximadamente tanto como el producto interno bruto en países SADC como la agricultura, la ingeniería forestal y la pesca combinadas-un desarrollo sorprendente y relativamente reciente realzado por la *Evaluación del Ecosistema Millenium* del 2004.[4] En consecuencia, una estrategia clave para la conservación de la biodiversidad en las TFCAs de África del Sur es asegurar la conectividad biológica a lo largo de paisajes más grandes en los cuales el centro de las regiones de las áreas protegidas está enfrentando el riesgo de volverse islas ecológicas en paisajes de agricultura, con la pérdida de conectividad tan importante para mantener la diversidad genética y la viabilidad de las poblaciones de vida silvestre en peligro de extinción global. También se considera que el aumento de la conectividad a lo largo de los grandes paisajes como el TFCA KAZA, es un factor crucial en la adaptación biológica al cambio climático en la región.

Desafortunadamente, la pérdida de importantes corredores de hábitat a través de las restricciones del uso del suelo, ocasionados por los requerimientos del control de las enfermedades, contribuye a la fragmentación de hábitat progresiva y a la pérdida de las rutas tradicionales de migración y dispersión en la región.[4] Los controles de enfermedades animales actuales dependen en gran medida de cientos de kilómetros de vallas y a estrictas regulaciones de mercados locales y de exportación para productos animales. Estas cercas de control de enfermedades y las barreras físicas y de uso de suelo que ellas crean, representan uno de los peligros más grandes para la conectividad traslinde y la visión de los vastos paisajes de conservación que buscan fomentar tanto la conservación como los beneficios de los sustentos en tierras semiáridas grandes, que pueden ser consideradas poco rentables para la agricultura.[4] El manejo de enfermedades de los animales silvestres y del ganado (incluyendo las zoonosis) dentro de KAZA sigue sin resolverse, y es un asunto político emergente de preocupación mayor para la producción del ganado, acceso asociado para los mercados de exportación y otros sectores, incluida la salud pública. El concepto TFCA promueve el libre movimiento de los animales silvestres en las grandes áreas geográficas, mientras que el abordaje actual para el control de las enfermedades animales transfronterizas (TADs, por sus siglas en inglés) es prevenir el movimiento de animales susceptibles entre las áreas donde ocurren las TADs y las áreas donde no ocurren, y de forma similar restringir el comercio de productos derivados de los animales con la misma base. El concepto TFCA y los abordajes actuales internacionalmente aceptados para el manejo de las TADs, son por lo tanto incompatibles en gran medida-una amenaza clave para el éxito de conservación trasfronterizo y la diversificación del riesgo de las opciones del uso de la tierra y las oportunidades de sustentos en la región.[4]

El programa *AHEAD* puesto en marcha en el 2003, pretende ayudar a resolver estos problemas y contribuir a la conservación de la biodiversidad y al realce de los sustentos rurales en KAZA. Esto puede lograrse colaborando para crear un ambiente con posibilidades para la mejoría en la cooperación entre la conservación, la agricultura y los expertos en salud humana y las autoridades dentro y entre los países miembros, identificando los mecanismos para controlar las TADs sin dependencia completa sobre los abordajes actuales de cercas, e informando e influenciando respuestas de políticas trasfronterizas que apoyen tanto a las TFCAs como el control de las TADs.[3]

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Las opiniones expresadas aquí son aquellas de los autores y no necesariamente reflejan los puntos de vista de la USAID o de otras organizaciones donantes.

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¿LA TOXOPLASMOSIS ES UNA ENFERMEDAD EMERGENTE POTENCIAL PARA LA VIDA SILVESTRE, LOS ANIMALES DOMÉSTICOS Y LOS HUMANOS EN MONGOLIA?

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Resumen

El gato de Pallas (*Otocolobus manul*), un felino de tamaño pequeño nativo de la parte Central de Asia, es excepcionalmente susceptible entre las especies de gatos a la mortalidad causada por la toxoplasmosis, tal vez como consecuencia de su historia evolutiva.

En nuestra investigación inicial en Mongolia, identificamos dos gatos de Pallas silvestres (2/15, 13%) que fueron seropositivos para la exposición al *Toxoplasma*, pero se encontraron individuos no seropositivos entre los gatos domésticos muestreados (0/15) y los roedores silvestres (0/45).[1] En este estudio de seguimiento, hemos expandido nuestra inspección en Mongolia para incluir humanos y ungulados domésticos, así como aves silvestres y más gatos de Pallas y roedores. Se obtuvieron muestras de suero de Mongoles nativos (n=300) de manera oportunista, de ciudadanos que daban su sangre para exámenes de salud de rutina. También se colectaron muestras de sangre de ovejas y cabras domésticas (n=300) en hatos localizados en nuestro principal sitio de campo en el centro de Mongolia, y en las estepas de praderas de Mongolia del Este.

Se colectaron muestras de suero de dos especies de aves migratorias (ganso cabeza con franja, *Anser indicus*; ganso cisne, *A. cygnoides*; n = 189) en la parte norte-central de Mongolia como parte del programa Vigilancia Aviar Global en Red para la Influenza de la WCS-USAID (GAINS, por sus siglas en inglés). Se obtuvieron muestras sanguíneas adicionales de roedores (n=45) y de gato de Pallas (n=19) en el sitio de campo primario. Las muestras de suero fueron evaluadas para anticuerpos anti-*Toxoplasma* en un título simple (1:16-1:64, dependiendo de la especie) usando una prueba de aglutinación en látex (Toxotest MT, Tanabe USA, Inc., San Diego, CA, 92111 USA).

Los resultados indican que solo dos de los Mongoles muestreados (0.7%; 2/300) tuvieron anticuerpos contra *Toxoplasma*, mientras que ninguno (0%; 0/45) de los roedores muestreados y solo unos cuantos (1.2%; 4/300) de los ungulados tenían títulos anti-*Toxoplasma.* A pesar de que solo 1 de 19 (5.3%) de los gatos de Pallas fueron seropositivos, estos hallazgos, combinados con nuestra información inicial, confirman la existencia de algunos focos no definidos de exposición al *Toxoplasma.* Debido a que las aves acuáticas migratorias tienen una seroprevalencia muy elevada (104 de 189 positivos, 55.0%), sospechamos que los gatos de Pallas pueden estar expuestos esporádicamente vía ingestión de quistes en tejidos en estas presas potenciales, o de otras especies de aves migratorias. Estos nuevos hallazgos apoyan nuestra opinión de que el *Toxoplasma* no es en realidad un parásito endémico de Mongolia, sino que posiblemente es un patógeno transitorio, tal vez como un polizón intracelular en las aves silvestres.

La combinación de un clima extremadamente frío y árido, altitud elevada, muy pocos gatos domésticos y números limitados de felinos silvestres pueden comprometer la habilidad del *Toxoplasma* de completar su ciclo de vida natural. Estos resultados refuerzan la importancia de manejar a los gatos de Pallas, especialmente a las hembras en edad reproductiva, en un medioambiente libre de *Toxoplasma* en zoológicos para prevenir la toxoplasmosis fatal en crías recién nacidas.

En un contexto más amplio, estos hallazgos pueden tener implicaciones de salud pública importantes tanto para las mujeres gestantes como para la industria del ganado en Mongolia si la exposición al *Toxoplasma* se incrementa, debido a cambios en las prácticas culturales (ej. tenencia incrementada de gatos domésticos) y al clima global (ej. temperaturas más calientes de invierno que afectan la sobrevivencia de ooquistes del *Toxoplasma*). Se justificaría el comienzo de programas de vigilancia para poblaciones humanas y animales susceptibles en Mongolia.

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MONITOREO DE SALUD DE CHIMPANCÉS NATURALMENTE INFECTADOS CON SIVcpz: BENEFICIOS PARA CHIMPANCÉS Y HUMANOS

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Resumen

La pandemia por el virus de inmunodeficiencia humana tipo 1 (HIV-1, por sus siglas en inglés) ha dado lugar a un considerable interés en los modelos primates no humanos de inmunodeficiencia adquirida (SIDA). Se sabe que varias poblaciones de chimpancés silvestres están infectados naturalmente con el virus de inmunodeficiencia del simio (SIV, por sus siglas en inglés), incluyendo los chimpancés en el Parque Nacional Gombe.

Sin embargo, el impacto de esta infección en la salud y en la longevidad de los chimpancés, sigue sin conocerse. Los chimpancés del Gombe han estado bajo observación constante desde los 1960s, y para muchos de ellos existen historias de vida individuales. En el 2004, se agregó la patología al monitoreo observacional progresivo de salud y al estudio virológico no invasivo de los chimpancés y primates simpátricos del Gombe.

Se entrenó personal interno en las técnicas de necropsia para que los cuerpos de los primates muertos de manera natural pudieran ser evaluados de forma completa, pero segura. A pesar de que el objetivo inicial era monitorear la salud de esta población, el proyecto proporcionó una oportunidad única para estudiar la patogénesis de la infección natural por el SIVcpz. Antes de estos estudios, se pensaba que las infecciones naturales por el SIVcpz, incluidas las de los chimpancés, eran no patogénicas. No obstante, nuestros estudios revelaron altas tasas de mortalidad así como casos de chimpancés infectados por el SIVcpz con una inmunopatología similar al SIDA. Por lo tanto, nuestros hallazgos sugieren que el SIVcpz puede tener un impacto en la sobrevivencia de esta especie amenazada de extinción. La investigación progresiva sobre los factores virales y del hospedero, responsables de la progresión de la enfermedad puede aportar claves cruciales para comprender los mecanismos del SIDA. Mientras que la colaboración es común entre los investigadores que estudian la patogénesis de las enfermedades

humanas en condiciones de laboratorio, esta colaboración entre veterinarios y profesionales de la salud humana y conservacionistas tiene el potencial de incrementar nuestro entendimiento de la patogénesis de esta enfermedad para el beneficio de los humanos y los chimpancés.

LA APLICACIÓN DE ESTUDIOS BIO-MIMÉTICOS DE LOS SISTEMAS CARDIOVASCULARES DE JIRAFAS Y SERPIENTES ARBORÍCOLAS EN EL DESARROLLO DE UN DISPOSITIVO DE ASISTENCIA BIVENTRICULAR MODIFICADO (MBVAD)

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Resumen

Las turbinas eólicas son fuentes de energía alterna, pero contribuyen al incremento de la mortalidad de animales voladores. Las ventanas solares, las células energéticas y las turbinas eólicas localizadas en barriletes pueden ayudar a reducir estas mortalidades.[1,6]

El hidrógeno y el oxigeno de la célula energética del barrilete se convierten en agua y electricidad en el reactor de la célula energética localizado en la tierra.[2,11] Sin embargo, las diferencias de presión de los fluidos debidas a los cambios en la altura, representan los principales obstáculos de la ingeniería que deben resolverse antes de que estos barriletes sean colocados por encima de las rutas de vuelo de aves y murciélagos. Para resolver estos obstáculos, se desarrolló un dispositivo de asistencia biventricular modificado (MBVAD, por sus siglas en inglés) que mimetiza la biomecánica de los corazones de las jirafas y de las serpientes arborícolas.[3-5,9] El dispositivo MBVAD utiliza válvulas microsolenoides que imitan la función de las válvulas bilógicas. Se induce la presión sistólica y diastólica en los ventrículos llenos de agua por la expansión neumática y la contracción de las esferas de hule.[3,10] Esto permite a los tubos de hule transferir el agua del nivel de tierra a la célula energética del barrilete, así como conducir el hidrógeno y el oxigeno de la célula energética en el barrilete al reactor de la célula energética en la tierra. Por consiguiente, los inconvenientes ecológicos de las turbinas eólicas pueden rebatirse con el uso de modelos biológicos para resolver los problemas de ingeniería. En consecuencia, nuestro barrilete experimental representa el producto de Una Ciencia. Este es una unidad de producción de energía alternativa que fue desarrollada con la integración de conceptos de la ciencia veterinaria, la ecología, la química, la biofísica y la ingeniería.[7,8]

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SUSCEPTIBLIDAD ANTIMICROBIANA DE AISLADOS BACTERIANOS DE NUTRIAS MARINAS: UNA SALUD

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Resumen

A pesar de décadas de protección legal, la recuperación de la población de la nutria marina del sur (*Enhydra lutris nereis*) se ha dificultado por la elevada mortalidad, incluidas las muertes de animales adultos. Más del 50 % de la mortalidad de las nutrias marinas se ha atribuido a las intoxicaciones y a las infecciones por bacterias y parásitos.[3,7] Las bacterias entéricas potencialmente patógenas parecen ser más prevalentes a lo largo de las costas urbanizadas y cerca de las desembocaduras de los ríos, sugiriendo que la diseminación tierra-mar de los patógenos puede ser un componente importante de la exposición a algunas especies bacterianas (Miller et al., 2010).[5] Algunos aspectos de la biología de las nutrias marinas pueden hacerlas especialmente vulnerables a la infección por los contaminantes bacterianos en los residuos contaminados. Ellas se alimentan cerca de la orilla, con frecuencia dentro o a un lado de las plumas de agua de la superficie costera,[4,5] pueden descansar y hurgar en ensenadas protegidas cerca de los centros de poblaciones humanas,[2] mostrar agresión intraespecífica que con frecuencia termina con traumatismo de los tejidos blandos y el estrés continuo, y consumir grandes cantidades de presas invertebradas filtradas que pueden bioconcentrar patógenos, incluidas las bacterias.[6]

Los antibióticos son herramientas terapéuticas importantes para el manejo de las infecciones bacterianas en las nutrias marinas varadas, y para la prevención de las infecciones después de procedimientos invasivos en nutrias de vida silvestre. En el presente estudio, se determinó la susceptibilidad a los antibióticos comúnmente usados para 126 aislados de 15 especies o grupos bacterianos, de nutrias de río a las que se les practicó la necropsia, a aquellas vivas y varadas y a otras aparentemente saludables, evaluadas entre 1998 y 2005. Estos aislados incluyeron tanto cepas grampositivas como gramnegativas de patógenos conocidos, oportunistas y flora medioambiental, incluyendo especies bacterianas con potencial zoonótico comprobado.

Las nutrias de río son una especie marina centinela estupenda cuya fidelidad al lugar que habitan y otras características, permiten la identificación de fuentes locales de contaminación que pueden afectar la salud de los humanos, los animales domésticos y otras especiessilvestres.[1] Los

resultados de este estudio ponen énfasis en las fuentes potenciales de infecciones zoonóticas en aguas cercanas a la costa, usadas en gran medida para recreación, y podrían ayudar a optimizar la selección de los antibióticos apropiados para el tratamiento de infecciones bacterianas de las nutrias marinas, otras especies marinas y humanos en contacto con ellas. En este estudio se halló mínima evidencia de resistencia antimicrobiana, y no se identificaron cepas con patrones inusuales o clínicamente significativos de resistencia múltiple. Un incremento considerable en las evidencias sugiere que la recuperación de las poblaciones de nutrias marinas en California puede ser dependiente de la atenuación de una variedad de tipos y fuentes de contaminación, incluidos los patógenos bacterianos, y ellas proveen un ejemplo excelente de la manera en que el concepto "Una salud" puede ayudar a originar cambios positivos.

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CENTROS DE REPRODUCCIÓN Y "RESTAURANTES" – UNA ACTUALIZACIÓN DEL PROGRAMA DE ZOPILOTES EN LA INDIA Y NEPAL

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Resumen

La disminución de los zopilotes *Gyps* spp de la India, Nepal y Pakistán, que en algún tiempo fueron muy abundantes, y el inicio del trabajo para la conservación de estas especies ya ha sido presentado con anterioridad en la AAZV.[1] Aproximadamente seis años después de la fundación del primer centro de reproducción, el programa de conservación se acerca al final de la primera fase. La transición exitosa a la siguiente fase es crucial si se quieren alcanzar las metas a largo plazo de liberar a los animales al estado silvestre.

Se ha hecho mucho para eliminar la causa de la disminución de la especie, el AINE diclofenaco, pero a pesar de esto la declinación del zopilote continúa año con año. A pesar de que el fármaco ha sido prohibido por ley en muchos de los países de distribución de la especie, los residuos de diclofenaco aún son identificados en los tiraderos de cadáveres,.

Al comparar el diclofenaco con el meloxicam in vitro se ha demostrado la toxicidad relativa del diclofenaco.[2] El meloxicam parece ser seguro en los zopilotes y puede ser usado terapéuticamente. Sin embargo, no ha sido fácil el reemplazo del diclofenaco con el meloxicam en las comunidades granjeras y veterinarias. Además, el ketoprofeno, que antes se pensaba como una fuerte alternativa al diclofenaco, ahora se ha visto que es nefrotóxico en los zopilotes.[3]

El autor está involucrado con el manejo veterinario en colaboración en cuatro centros de reproducción: tres en India y uno en Nepal. Estos son manejados por socios de cada país: La Sociedad de Historia Natural de Bombay y el Fondo Nacional para la Conservación de la Naturaleza respectivamente (hay un quinto centro que ha sido establecido en Pakistán). Adicionalmente se ha proporcionado soporte técnico, tanto para el mantenimiento como para la reproducción, por parte de trabajadores de colecciones zoológicas del Reino Unido. El número total de aves de las tres especies (sin incluir la temporada reproductiva de 2010) en los cinco centros es de 283.[4] Esto es menor al número total de animales fundadores, 100 aves de cada especie, necesarios para mantener el 90% de la heterocigocidad actual, como ha sido determinado con el objetivo de mantener la diversidad genética de la especie a largo plazo.[5]

Muchas de las aves son relativamente jóvenes, habiendo sido capturadas de los nidos con los permisos correspondientes. La reproducción ha ocurrido ahora en aves de más edad en las tres especies mantenidas, denominadas el zopilote de dorso blanco Oriental, el de pico largo y el de pico delgado (*G. bengalensis*, *G. indicus* y *G. tenuirostris*, respectivamente). Para la temporada reproductiva de este año se usaron incubadoras por primera vez. Varias de las parejas tuvieron lo

que sería su primera única cría, criada artificialmente y entraron al proceso de producir un segundo pollo en la misma temporada.

Un factor limitante principal en este proyecto es el costo, en particular cuando se considera el número de años que necesita llevarse el programa de reproducción en cautiverio. Una alta proporción de estos costos, aportados por los donativos de la Real Sociedad de Vida Silvestre del Reino Unido para la Protección de las Aves, se destina a la alimentación de los animales y es de alrededor de 150,000 dólares por año. Se han buscado algunas fuentes alternas de carne, incluyendo las muertes eventuales de vida silvestre, evaluando de manera muy crítica el riesgo para el proyecto. Las investigaciones actuales indican que es posible tener una prueba de ELISA para identificar los residuos del diclofenaco en la carne. El beneficio que esto podría aportar es tener una fuente alterna de carne de ganado doméstico, con las limitaciones específicas de las religiones locales.

La Influenza Altamente Patógena (HPAI, por sus siglas en inglés) ha sido encontrada en las especies domésticas en los países del rango de distribución varias veces, incluso cerca de los centros de reproducción. Los abordajes formales ante las autoridades gubernamentales correspondientes no han tenido éxito para lograr que se implemente la liberación del embargo en la importación y uso de la vacuna de virus muerto de HPAI y H5N1. Las medidas preventivas aún están limitadas a la bioseguridad y a la exclusión de aves silvestres.

En un proyecto en colaboración con las comunidades locales, la Conservación de las Aves de Nepal, ha establecido una instalación descrita coloquialmente como el “restaurante de los zopilotes” en las áreas rurales. Se han establecido áreas de alimentación y donde las aves pueden esconderse, y se está realizando en la localidad un programa activo de reemplazo del diclofenaco. Se compran individuos viejos de ganado bovino y se mantienen hasta su muerte, momento en el cual se utilizan para alimentar a los zopilotes. Esto puede observarse desde puntos escondidos y los visitantes pagan una cuota que regresa a la comunidad local. El número de los zopilotes se ha incrementado conforme las aves se han movido a estas áreas y se ha llevado a cabo la reproducción. La desventaja es que estas aves no están confinadas, significando que pueden alejarse volando cierta distancia y consumir cadáveres que contengan cantidades fatales de diclofenaco. En un evento reciente apoyado por el gobierno se hizo la destrucción de 50 litros y 13,000 bolos de diclofenaco, con el objeto de destacar el trabajo que se está realizando para la conservación de los zopilotes.

Los efectos en la declinación de los zopilotes se extienden hasta las comunidades locales y afectan la salud comunitaria. Sin los zopilotes para disponer de la carroña ha habido un aumento concomitante en la población de perros callejeros. Junto con esto ha habido un aumento en el número de casos de rabia humana, con un estudio que atribuye a este efecto un estimado de 47,300 muertes en el periodo de 1992 a 2006.[6]

El año 2010 significa el inicio de la segunda etapa del proyecto: la de la consolidación. Una función primordial de todo el grupo es mantener y reproducir a los zopilotes en cautiverio de manera que pueda ocurrir el programa de liberación. Quedan pocos zopilotes en vida libre. La amenaza de la toxicidad de los AINES significa que aún están en riesgo y con base en las

tendencias actuales, cualquiera de las tres especies o todas ellas podrían extinguirse en vida libre. Sin embargo, es necesario eliminar el diclofenaco del ambiente para alcanzar la salud del ecosistema y que las generaciones de los zopilotes puedan llegar a permanecer como supervivientes de estas aves de presa anteriormente abundantes.

RECONOCIMIENTOS

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INVESTIGACIÓN DEL PAPEL DE LAS ENFERMEDADES EN LA DECLINACIÓN DE LAS POBLACIONES DE LOROS DE PICO GRUESO (*Cotorra serrana*) EN EL NORESTE DE MEXICO

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Resumen

Los loros de pico grueso (TBPs por sus siglas en inglés), o cotorras serranas (*Rhynchopsitta pachyrhyncha pachyrhyncha*) están enlistados en el Apéndice I de CITES como Especie Amenazada y alguna vez se distribuyeron desde el sudoeste de Estados Unidos hasta el norte de México. Su rango de distribución actual está limitado a los bosques de pino de la Sierra Madre Occidental de México. Las poblaciones actuales están amenazadas por la destrucción y degradación de su hábitat. No existe información disponible del papel que juegan las enfermedades en el declive de la población. Nosotros hemos propuesto la hipótesis de que el cambio climático que está provocando cambios en la prevalencia de vectores, aumenta el riesgo de la amenaza por las enfermedades en las poblaciones silvestres. En 2003, el 20% de todas las muertes de las cotorras cautivas en Estados Unidos se debió a la infección del Virus del Oeste del Nilo (VON). El impacto de la infección por el Virus del Oeste del Nilo en la población de humanos y animales en México ha sido menor que en Estados Unidos, probablemente debido a la exposición previa a otros flavivirus. La cotorra serrana anida a más de 2000 metros. Estos hábitats a gran altitud pueden limitar la actividad del mosquito. Si la actividad del mosquito está limitada, entonces la exposición a otros flavivirus que protegen de manera cruzada contra el VON también estarán limitadas. Nosotros comenzamos el programa de monitoreo del hábitat y salud en 4 sitios de anidación en la Sierra Madre para definir mejor el papel de las enfermedades en esta región. Identificamos mosquitos vectores de VON *Culex quinquefasciatus* y *C. tarsalis* en dos de los sitios de estudio. Se colectaron muestras de suero de 24 pollos y fueron negativos a VON y al Virus de la Encefalitis de San Luis. Utilizando un laboratorio molecular móvil se realizaron estudios de campo in situ en muestras colectadas de pollos muertos. El bazo y el hígado fueron positivos a flavivirus no VON. No pudimos de demostrar que este virus haya contribuido a la muerte de las crías.

ALTA PREVALENCIA DE CÁNCER DEL CANAL AUDITIVO EN LAS ZORRAS DE LAS ISLAS CATALINA, AMENAZADAS DE EXTINCIÓN (*Urocyon littoralis catalinae*)

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Resumen

Desde 2001 se ha detectado un inusual alto número de carcinomas de la glándula de cerumen (CGC) y adenomas de la glándula de cerumen (CGA) (denominados en conjunto como tumores) en las zorras de las Islas de Catalina (*Urocyon littoralis catalinae*), las cuales están en peligro de extinción. Los CGC pueden tener un curso clínico agresivo con invasión local o metástasis, y tanto los CGC como los CGA pueden cursar como enfermedad crónica caracterizada por otitis externa severa y/o septicemia fatal. Para determinar la prevalencia y los factores de riesgo para estos tumores se evaluaron 357 zorros de las Islas de Catalina, Islas de San Nicolás e Islas de San Clemente y se obtuvieron 156 biopsias para histopatología y muestras para ácaros, bacterias, virus y toxinas. Los tumores solo se encontraron en los zorros de la Isla de Santa Catalina. Dentro de los zorros de ≥ 4 años de edad, el 48% tuvo tumores, 2/3 de los cuales fueron CGC. La condición más importante asociada con CGC fue la otitis externa severa con hiperplasia de la glándula de cerumen, estimulada por la infección con ácaros locales. Estas lesiones fueron más severas en los zorros de la Isla de Santa Catalina que en los de otras islas, a pesar de que la prevalencia de los ácaros fue cercana al 100% en todas las islas. No se detectó ningún virus y no hubo ninguna asociación significativa entre toxinas o bacterias con la presentación de los tumores. Este estudio presenta un alto nivel de tumores cancerosos y no cancerosos en una población silvestre. Aún está bajo investigación el hecho de que estos tumores ocurran en los zorros de las Islas de Santa Catalina debido a una probable predisposición genética o a otros factores como los ácaros. El tratamiento de 57 zorros de la Isla de Santa Catarina para los ácaros de las orejas resultó en la ausencia del parásito y una reducción visible de la inflamación en 36 de los 40 animales estudiados y recapturados en 6 meses. La histopatología de las biopsias previas y posteriores al tratamiento aún está procesándose.

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ENFERMEDAD ASOCIADA A ASTROVIRUS EN ARDILLAS GRISES HUERFANAS (*Sciurus carolinensis*)

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Resumen

Se identificó un astrovirus en ardillas grises huérfanas (*Sciurus carolinensis*) las cuales se criaron de forma artificial en un centro de rehabilitación de fauna silvestre. Un grupo de 14 ardillas presentaron un cuadro agudo de enfermedad con timpanismo, depresión, náusea y diarrea mucosa severa. Se realizaron varias pruebas fecales seriadas sin que se encontraran parásitos y los cultivos de las heces, biberones, tazones y la fórmula utilizada para alimentarlos no revelaron patógenos GI. Todas las ardillas afectadas fueron tratadas con metoclopramida, fluidos subcutáneos, sulfas-trimetropim o metronidazol y gotas de simeticona. El veintiún por ciento (3/14) de los animales murieron en las primeras 24 horas de que aparecieron los signos. El resto de las ardillas mejoraron después de 4 días y estuvieron clínicamente normales en 10 días. Durante la necropsia se encontraron partículas de astrovirus al utilizar un microscopio electrónico en muestras de intestino de una ardilla, así como en muestras de heces obtenidas de otras ardillas afectadas. La prueba de PCR y la secuencia de estas muestras de heces revelaron dos distintos astrovirus nuevos en el género *Mamastrovirus*, uno de los cuales se encontró en todos los animales evaluados. Los astrovirus son una familia de virus RNA que han sido identificados en varias especies animales al igual que en varias especies de aves. [1,3] Los astrovirus de humanos son una de las principales causas de diarrea en niños, y los astrovirus de pavos causan bajas tasas de crecimiento en las parvadas afectadas. [1,3] Al inducir un aumento en la permeabilidad de la barrera epitelial, los astrovirus causan una diarrea mucosa severa sin que se encuentren cambios histopatológicos significativos, [2,4] Los signos clínicos mostrados en este grupo de ardillas son similares a los observados en otras especies, aunque con una mortalidad más alta. Hasta donde nosotros tenemos conocimiento, los astrovirus no habían sido identificados previamente en ardillas grises.

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USO DE IMPLANTES VFH PEQUEÑOS PARA RADIOTELEMETRÍA EN ORANGUTANES SILVESTRES REINTRODUCIDOS (*Pongo pygmaeus*)

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Resumen

Existen numerosas instalaciones para la rehabilitación y reintroducción de orangutanes a lo largo del rango de distribución de la especie. Solamente en Indonesia alrededor de 1200 animales son mantenidos hoy en día. El valor e impacto para la conservación de estas instituciones es controvertido.[2] Debido a la falta de datos, un punto que se discute de manera repetida e insatisfactoria es el éxito de las medidas de reintroducción. En el pasado la radiotelemetría ha sido vista como impráctica e incluso peligrosa en esta especie.[1] Con el objeto de proporcionarle a las diferentes instituciones una solución para el monitoreo de los animales, nosotros desarrollamos un transmisor VHF que es un implante pequeño. La unidad está controlada por un circuito de sincronización del tiempo de bajo voltaje que le da una vida útil de varios años. El calendario preprogramado de transmisión VHF (1-7 días a la semana y hasta 24 horas por día) es activado por el usuario en el campo. El circuito electrónico está albergado en un CNC, cubierto por cerámica inerte y sellado herméticamente con un pegamento adhesivo especialmente formulado. Se usó una interfase magnética para cambiar la unidad al modo de descanso con ultra bajo voltaje o comenzar la transmisión en el itinerario programado. Las dimensiones físicas del implante estándar es de 28 mm de diámetro y 9 mm de largo. Para extender la duración del tiempo de vida teórico del transmisor existe una versión con una batería de mayor capacidad, lo que incrementa el largo de transmisor a 11 mm. El peso de los implantes es de 13 g para el tamaño estándar y 16 g para el tamaño mayor. Para seguir la señal del implante se usa un receptor estándar y una antena adecuada que cubra el rango de la frecuencia de 142 a 143 MHz. Después de hacer los seguimientos iniciales en las instalaciones de un zoológico, los primeros implantes se llevaron al Centro de Rehabilitación de Orangutanes de Sepilok, en Sabah, Malasia. Las unidades fueron implantadas quirúrgicamente en un pliegue subcutáneo en la región dorsal del cuello. Después de colocarlo, se colocó una sutura estándar en dos planos. Las primeras pruebas de campo han demostrado que estos implantes facilitan en gran medida el seguimiento de los orangutanes en el campo. Con alrededor de 600 animales esperando su liberación en Indonesia y alrededor de 50 en Malasia, estos implantes serán una herramienta valiosa para poder evaluar la reintroducción de los orangutanes.

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PARTICIPACIÓN VETERINARIA EN EL PROYECTO DE LOS FELINOS SILVESTRES DE BORNEO Y LA PANTERA NEBULOSA

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Resumen

En 2006 se estableció el Proyecto de los Felinos Silvestres y la Pantera Nebulosa de Borneo para proporcionar datos precisos sobre la ecología y biología de los felinos silvestres de Borneo, y para apoyar con el manejo y la conservación de estas especies. Las selvas de Borneo mantienen cinco especies de felinos silvestres: la pantera nebulosa de Sunda (*Neofelis diardi*), el gato marmoleado (*Pardofelis marmorata*), gato de la bahía (*Pardofelis badia*), el gato de cabeza plana (*Prionailurus planiceps*), y el gato leopardo (*Prionailurus bengalensis*). La pantera nebulosa de Sunda y el gato marmoleado están considerados como *Vulnerables* por la Unión para la Conservación de la Naturaleza (IUCN, por sus siglas en inglés).[2] El gato de la bahía y el de cabeza plana están *Amenazados*. Solo el gato leopardo no está considerado en alguna categoría de amenaza. Una de las mayores amenazas para los felinos de Borneo es la pérdida de hábitat como resultado de la deforestación y la conversión para uso agrícola, como es el caso de las plantaciones de la palma aceitera. [3] Actualmente solo 52% de la selva de la isla permanece sin modificación. [5] Aunque las cuatro especies de felinos amenazados no habitan en las plantaciones de palma, sí se ha reportado que el gato leopardo utiliza este hábitat. [1,4] Otras amenazas potenciales para los felinos de Borneo incluyen la cacería ilegal de los gatos y sus presas y las enfermedades transmitidas de los perros y gatos ferales. El papel del veterinario en este proyecto incluye la inmovilización química segura, la obtención de datos de hematología y bioquímica en las diferentes especies, el desarrollo de protocolos de inmovilización seguros y la documentación de los parámetros de salud de estos felinos silvestres.

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ECOLOGÍA, ANESTESIA Y EVALUACIONES OFTALMOLÓGICAS PRELIMINARES EN HIENA CAFÉ (*Hyena brunnea*) EN NAMIBIA, AFRICA

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Resumen

Existen cuatro especies de hienas: la café (*Hyaena brunnea*), la moteada (*Croctua croctua*), la rayada (*Hyaena hyaena*) y el Aardwolf (*Proteles cristata*). La hiena café es uno de los mamíferos carroñeros más grandes de África. Los machos pesan 40.2 +/- 3.0 kg, y las hembras 37.6 +/- 3.4 kg. Tienen mandíbulas poderosas, una cubierta de pelo larga y abundante y miembros torácicos y hombros muy fuertes. En comparación, los miembros posteriores son relativamente débiles. La hiena café es un cazador nocturno solitario y viaja de 25 a 40 km por noche en busca de alimento. Viven en clanes pequeños compuestos de un solo macho, una hembra y sus crías. Ellos marcan sus territorios y se comunican a través de secreciones anales que dejan en la vegetación. Aunque se piensa que son predominantemente carroñeras, las hienas cazan de manera activa y consumen crías de lobo marino peletero del Cabo, (*Arctocephalus pusillus*).

Se estima que existen de 5,000-8,000 hienas cafés silvestres; todas las poblaciones están localizadas en la parte central, oeste y sur de África. La población estimada de Namibia es de entre 800 a 1,000 individuos. La hiena café está considerada como un depredador primario a lo largo de la Costa Esqueleto de Namibia, que es un ambiente desértico frío. Las minas de diamantes, los traumatismos vehiculares y la cacería por humanos amenazan a las poblaciones de hienas existentes.

En mayo de 2009, como parte del Proyecto de Investigación de Hiena Café, se hicieron 7 intentos de inmovilización de hienas café durante un periodo de 17 días, siendo 4 exitosos, utilizando una combinación de 80 mg de hidrocloruro de ketamina y 1.4 mg hidrocloruro de medetomidina utilizando una inyección remota (Telinject, Inc. Agua Dulce, California 91350 USA).

Los efectos clínicos se notaron en tres minutos y los cuatro animales estaban en recumbencia en un promedio de 7 minutos. Los cuatro animales fueron hembras. El examen clínico y el monitoreo anestésico incluyeron el examen físico, dental, orofaríngeo, determinación de la edad y sexo, estado gestacional, oximetría de pulso, estetoscopio, temperatura, flebotomía para guardar muestras para el banco de sueros, biopsia de piel, colocación de un collar satelital para localización global (GPS) y foto identificación. La evaluación oftalmológica inicial incluyó el uso del oftalmoscopio directo, la prueba de producción de lágrima de Schirmer ® la tonometría de Schiotz y la tinción con fluoresceína en la cornea. En un individuo se encontró hialosis asteroidea y úlceras cornales puntuales.

Los cuatro animales estuvieron estables durante el procedimiento y fueron revertidos con 7 mg de hidrocloruro de atipamezol i.m. La recuperación ocurrió en 5 minutos en cada animal y los cuatro individuos se recuperaron sin complicaciones. El monitoreo con GPS ha continuado documentando los ámbitos de distribución de cada individuo.

Los planes futuros incluyen la evaluación de títulos virales, química sérica, hormonas fecales, evaluación de parásitos internos y externos y el impacto de los animales domésticos en la ecología de la hiena café.

Hay numerosos retos que limitan poder disparar un dardo de manera exitosa en las hienas café. La localización tan remota y aislada, las restricciones gubernamentales, el clima, los animales venenosos y la falta de infraestructura y materiales; además de la naturaleza nocturna de las hienas representan hasta el momento retos difíciles de solucionar. Por el momento estos retos inhiben una evaluación real de la salud y estatus de las hienas café a lo largo de la Costa Esqueleto de Namibia.

VETERINARY ASPECTS OF HELLBENDER CONSERVATION PROGRAMS

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Abstract

The hellbender (*Cryptobranchus alleganiesis*) is a large aquatic salamander native to the United States.[6,10] Hellbenders in the wild are threatened by stream impoundment, channelization, agricultural runoff (chemical and siltation), disturbances caused by recreational use, and thermal changes.[11] *Batrachochytrium dendrobatidis* (Bd) and ranavirus infection have been identified in wild populations[2,3,13] but the significance is unknown. Several gastrointestinal parasites have also been detected, but none appear to be clinically significant.[4,12] Leeches (*Placobdella cryptobranchii*, are often present[8] and may be the vector of *Trypanosoma cryptobranchi*. Traumatic injuries to digits and appendages appear to be relatively common, and wild hellbenders are frequently found missing digits or limbs.[5]

In captivity, Bd may be significant in compromised hellbenders. Saprolegniasis is usually superficial and often associated with dermal lesions. Wounds may occur from intraspecific aggression, trauma, or exhibit materials. Persistent wounds may be a source of infection leading to sepsis. Hellbenders can be anesthetized with tricaine methanesulfonate (MS-222; 0.025%, or 250 mg/L). For surgical procedures, absorbable suture may dehisce; therefore it is recommended to use nylon suture material in both internal and external layers. Radiography and ultrasonography are useful imaging modalities. Phlebotomy is performed from the caudal vein located along the ventral aspect of the tail. Injectable antibiotics are preferred to oral or topical (soaks) administration in hellbenders.[7] Antifungal therapy may be necessary for management of Bd infections. Itraconazole soaks,[9] hyperthermia,[14] and topical chloramphenicol[1] may be effective.

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"BROWN SKIN SYNDROME" IN THE PUERTO RICAN CRESTED TOAD (*Bufo* (*Peltophryne*) *lemur*)

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Abstract

The Puerto Rican crested toad is critically endangered with a greater than 80% population decline in the last decade, and fewer than 250 mature individuals residing in the wild in Puerto Rico. Captive breeding and reintroduction programs began in the early 1980s. Recently, metamorphs found at release sites demonstrate the development of a second viable population. Since 2004, the success of the captive breeding program at the Toronto Zoo has been hampered by a condition known as "Brown Skin Syndrome". Adult and juvenile toads develop dark shiny skin on their dorsal and ventral surfaces, with apparent dysecdysis. Fragments of the outer layer of epidermis adhere to the underlying skin layer, rather than being shed in sheets, and occasionally dark pigmented debris accumulates within the oral cavity. Affected toads have chronic weight loss, fail to thrive, and eventually die. Histopathologic findings include cutaneous epithelial hyperkeratosis, ulceration, a thick Eberth-Katschenko dermal calcium layer, and occasionally glomerulonephropathy, enteritis, and squamous metaplasia of lingual glands. Response to soaking, antibiotics, antifungals, and various nutritional supplements has been inconsistent. A cause has not been identified, but a nutritional imbalance is suspected. In 2003, 'Specified Risk Materials' were removed from the food supply, and various animal-derived constituents of dietary supplements were replaced with synthetic forms. While these supplements, used to gut load and dust crickets, the primary dietary component of the captive toads, appear to contain adequate vitamin A on analysis, it may not be fully bioavailable or bioactive.

VITAMIN A (RETINOL) DETERMINATION IN HYBRID HOUSTON TOADS (*Bufo houstonensis* x *woodhousii*) AFTER TOPICAL ADMINISTRATION

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Abstract

Hypovitaminosis A has been suggested as a cause of morbidity in captive amphibian species. A study was designed to evaluate the efficacy of topical supplementation of Vitamin A in 24 Houston toad hybrids (*Bufo houstonensis* x *woodhousii*.). Group A (6.6 animals) was treated with 150 USP vitamin A[a] topically on the ventrum, every 3-7 days for 21 treatments. Group B (6.6 animals) was treated with sterile saline. Blood retinol was measured at the start and end of the study. A liver biopsy was taken at the end of the study and analyzed for retinol concentration. Blood retinol levels decreased over time but there was no difference between groups. Average pre treatment retinol was 46.26 μg/ml ± 64.13 μg/ml for both groups. Post treatment retinol was 3.46 μg/ml ± 3.75 μg/ml in Group A and 4.51 μg/ml ± 4.93 μg/ml in Group B. No difference was seen between the groups in the liver retinol values (Group A: 3.74 μg/g ± 3.87 μg/g, Group B: 2.96 μg/g ± 3.89 μg/g).

These results suggest that topical absorption of vitamin A was not effective in this species and there was no correlation between the blood and the liver retinol values. Hepatic retinol values overall were very low compared to other amphibians, but more wild Houston toad samples are needed for comparison. A liver biopsy may be a viable alternative to euthanasia in toads weighing more than 35 grams.

More studies are underway to evaluate the efficacy of oral administration of Aquasol-A (Mayne Pharma, Paramus NJ 07652, USA) in this species.

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OCCURRENCE OF *Batrachochytrium dendrobatidis* IN CAPTIVE AMPHIBIAN POPULATIONS IN THE UNITED STATES: IMPLICATIONS FOR HEALTHY SURVIVAL ASSURANCE COLONIES

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Abstract

The detection and control of emerging infectious diseases such as chytridiomycosis are key considerations for facilities with captive amphibians. This study uses a large diagnostic testing database to describe the occurrence of *Batrachochytrium dendrobatidis* (Bd) in captive amphibians and to examine testing and treatment strategies. From February, 2009, to March, 2010, 4400 skin swabs from 67 submitting institutions were processed for real-time PCR testing for Bd.[1] Information gathered for each sample included species, clinical signs, reason for testing, and treatments used. Of samples from seven partner institutions in which the entire amphibian collection was screened, the percent Bd-positive ranged from 0.0% to 4.6%. When samples were grouped by testing category, the percent Bd-positive was highest for quarantine screening and in cases of exposure to infected animals, and lowest in surveillance of apparently healthy collection animals. As noted previously,[1] multiple samples were sometimes needed to detect all animals with low-level (subclinical) Bd infection; this has implications for quarantine testing. The most common treatment for Bd infected animals was a 0.01% itraconazole bath,[2] however, lower doses were also effective. Clearance of Bd infection following treatment was verified by serial PCR testing. Treatment failures were rare, and causes included re-exposure to Bd due to inadequate disinfection. An experimental assay compared PCR results from different commercially-available swab types inoculated with known quantities of Bd zoospores. Wood-handled cotton swabs had poor test performance when compared to rayon-tipped swabs. These findings highlight the importance of appropriate biosecurity and testing protocols to reduce the threats of infectious diseases in captive survival assurance colonies.

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EVALUATING TOURISM AND FOOD SUPPLEMENTATION EFFECTS ON IGUANAS OF THE EXUMA ISLANDS, BAHAMAS (*Cyclura cychlura figginsi, C. c. inornata*)

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Abstract

Iguanas of the Exuma Islands, Bahamas (*Cyclura cychlura figginsi*, *C. c. inornata*) are listed as critically endangered and endangered, respectively, by the International Union for the Conservation of Nature (IUCN). Both are CITES Appendix I species. The population of each subspecies is fragmented and numbers less than 2,500 animals. Tourist visitation and food supplementation is an increasingly popular pastime in the Exuma Islands, and is a potential threat to both individual and population health of the iguanas. Anecdotal evidence of behavioral and physiologic (e.g., fecal quality) changes support this concern.

To assess the impact of tourist activities on these iguanas, behavioral trials, morphometric measurements, and physiologic parameters were evaluated for animals (total n>150) on five islands (no tourism, n=2; tourism, n=3). Iguanas were captured and a blood sample was collected within 3 min from the ventral coccygeal vein. An aliquot was immediately analyzed for glucose, sodium, potassium, ionized calcium, hematocrit, hemoglobin, pH, partial pressure of carbon dioxide, partial pressure of oxygen, total carbon dioxide, bicarbonate, base excess, and oxygen saturation with an i-STAT® analyzer and CG8+ cartridge[a] (Abbott Point of Care, Inc., Princeton, NJ 08540 USA). The remainder of the sample was placed in lithium heparin tubes on ice for later complete blood counts with the Avian Leukopet™ (Vetlab Supply, Palmetto Bay, FL 33157 USA) and collection of plasma. Plasma analyses included a standard reptile biochemical panel (glucose, sodium, potassium, calcium, phosphorus, total protein, albumin, globulin, cholesterol, uric acid, alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, creatine kinase, lactate dehydrogenase), protein electrophoresis, 25-hydroxyvitamin D_3, vitamin E, vitamin A, beta-carotene, trace mineral panel (cobalt, copper, iron, manganese, molybdenum, selenium, zinc), and corticosterone. A second blood sample was collected 30–45 min after capture for evaluation of glucocorticoid stress response. Behavioral and physiologic data were analyzed for differences based on island, intra-island location (i.e., central area v. periphery), and sex. Results will inform future conservation management plans for iguanas in the Exuma Islands.

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"PROJECT HELODERMA": AN IN-SITU CONSERVATION PROGRAM FOR THE GUATEMALAN BEADED LIZARD (*Heloderma charlesbogerti*)

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Abstract

The Guatemalan beaded lizard (*Heloderma charlesbogerti*) has not been formally IUCN Red listed as a subspecies, but is clearly critically endangered with an estimated 100-200 individuals remaining in its dry forest habitat, the size of a Texas cattle ranch, surrounded by unsuitable terrain.

Severe pressures including habitat loss and degradation, illegal collection, and indiscriminate killing by local villagers, threaten this animal with imminent extinction. After many reports of a beaded lizard from the Motagua valley of Guatemala, scientists first observed a specimen in 1984 and later described *Heloderma charlesbogerti* in 1988. With no reports of live individuals from the time of its description into the mid 1990s, the lizard was thought by some scientists to be extinct.

Project Heloderma: The Beginning

In June 2002 Zootropic, a Guatemalan NGO, began a long-term, integrated conservation program for the Guatemalan beaded lizard (*Heloderma charlesbogerti*) involving field research, public education, local community capacity building, and habitat protection. In that year Luis Alvarado and Rodrigo Botrán, of Zootropic, were searching for a student to conduct a research project on Heloderma. Dr. Michael Dix of the University of Guatemala put them in contact with Daniel Ariano, a 20-yr-old undergraduate with a keen interest in both herpetology and conservation. This interest led him to accept the challenge and risk of trying to develop a research project with such a rare and elusive species.

As is true of many grass roots conservation efforts, the start of Project Heloderma was not easy. Only very limited funding ($40/mo) was available from Zootropic, but was sufficient to cover two bus trips to the research site. No vehicles were available and the trip from Guatemala City to the site in the Motagua valley took 7 hr each way. Daniel was able on his own to secure funds from other sources to be able to conduct research and to eat.

Again, as is true of many conservation projects, trial-and-error and luck play major roles in success or failure. Knowing virtually nothing about the species, Daniel traveled to the type locality and interviewed local villagers about their experience with beaded lizards and its continued existence in the area. As luck would have it, a keystone step in the success of the

project occurred when Daniel met a particular villager named Gilberto Salazar. A local newspaper ran an article highlighting El Arenal, a town in the Motagua valley, featuring a photo of Gilberto with a Guatemalan beaded lizard. The caption on the photo described Gilberto as a poacher who sold the animals to traders. This photo was proof that the lizard still existed, at least until recently, and that Gilberto knew how to find them, so Daniel went to search for the town and to look for Gilberto.

Once Daniel finally found Gilberto there was more work to be done. An angry Gilberto confronted Daniel at gun point to find out what he wanted from him. After a long conversation, from a distance, Gilberto finally agreed to show Daniel beaded lizard habitat. This was the beginning of a wonderful association with the program in which Gilberto transitioned from a poacher to an active conservationist, became an expert in radio telemetry techniques, and is now employed by Project Heloderma.

Overall Conservation Program

In the 8-plus yr that Project Heloderma has been active, the beaded lizard has become a flagship species for the Motagua Valley and the impetus for the government of Guatemala to undertake initiatives to conserve its dry forest habitat. In November 2005, with sponsorship from The Nature Conservancy, Zootropic organized and hosted a strategic planning workshop in Guatemala that developed a National Strategy for Guatemalan Beaded Lizard Conservation. The workshop was attended by all the principal governmental agencies responsible for conservation initiatives in Guatemala, along with outside conservation groups and zoological institutions including: Dr. Daniel Beck, Detroit Zoo, Arizona-Sonora Desert Museum, and Zoo Atlanta. In 2006, the Project's capacity, vision and technical capability were greatly enhanced by the addition of the International Reptile Conservation Foundation (IRCF) as a new partner. At present, the Project's principal partners are Zootropic, IRCF, and Zoo Atlanta. Our mission is to conserve the critically endangered Guatemalan beaded lizard and its habitat in the Motagua Valley by means of an integrated program of research, public awareness and education, local capacity building, ecological restoration, head start and reintroduction efforts, and habitat management.

In-situ Field Initiatives

The initial field surveys and subsequent radio telemetry studies established and provided essential data concerning population size, population viability, activity, land use, home-range size, shelter use during the dry season and for egg laying, reproductive biology, and important micro-habitats. Using this data as a guide, a critical piece of mountain habitat was purchased (funded by grants from Eli Lilly, Reptile Breeders Expo, Toronto Zoo, and Oklahoma City Zoo); the site comprises a 125 acre footprint (total land area of 1,000 acres).

In addition, funding for a stage-one breeding/head start facility has been obtained (funded by a grant from FCA of Guatemala) and is currently in the design phase. Once completed, local villagers will be hired to run the day-to-day operations. Recently, Zootropic has set up three pairs of Guatemalan beaded lizards in breeding groups in conjunction with the Museum of Natural

History in Guatemala City and with improved husbandry based on field study data; these animals have produced eggs (non-viable) for the first time in 7 yr. With this news, there is hope that these animals will serve as the founding group once the breeding facility is completed. The data from the Project's field studies has served to successfully bring about the elevation of the beaded lizard to CITES Appendix I conservation status.

Veterinary involvement to date has consisted of transmitter placement, visual examination, and hands-on health assessments each year. In 2011, plans are in place to begin gathering hematologic data during different seasons. This data will include CBC and chemistry panels, as well as determination of serum concentrations of select vitamins and minerals.

Education Initiatives

The Guatemalan beaded lizard has historically been greatly feared by the local people due to its notoriety as a highly venomous and very dangerous animal. According to myth, the lizard stings with its tail (hence the name Escorpión or scorpion); its venom is so powerful that it can pass through the shadow of a person to envenomate them; its breath can cause dizziness and disorientation in people; and lightning only strikes where a lizard is hidden underground.

The education program has concentrated on dispelling these myths and involving the local people in the conservation process. Today the education program, with the help of two grants from the Disney World Wide Conservation Fund, has been expanded to a lecture series complete with a portable speaker system. With the donation of a four-wheel drive vehicle (grant from IRCF) the program is able to visit all the schools surrounding potential lizard habitat in the valley. The Disney grants provided for "needs based" distribution of conservation themed t-shirts to the children at each school visited in 2007–2008; followed by notebooks, paper, and pencils (like gold in the valley) in 2008–2009 and computers for each school for 2009-2010.

By the end of 2008 more than 30,000 school children and farmers in the Motagua Valley had attended the program, which includes presentation of live specimens, informational handouts, interactive magazines, and learner assessment questionnaires. The people have learned through this interaction (especially with the live beaded lizard) that the myths they grew up with are false. Directly because of this program the number of lizards killed by local inhabitants has been reduced to near zero. The program maintains a high profile locally, and recently has garnered some international awareness through public media, international meetings, and political outreach. Indeed a cement company in the valley calls its product "Escorpión – a cement strong enough to resist the dry climate of Motagua". In addition, this program has fostered a great deal of local community pride by involving people in the conservation of the endemic beaded lizard. This ability to work with local villagers and top governmental agencies is critical for a long term conservation program.

EVALUATING THE POTENTIAL FOR PATHOGEN DISSEMINATION WITH A BLANDING'S TURTLES (*Emydoidea blandingii*) HEAD START PROGRAM

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Abstract

There are a number of different conservation methods that have been initiated to protect chelonians. For those species where reproduction is successful but recruitment is poor, initiating a head-starting program may be beneficial. Blanding's turtles (*Emydoidea blandingii*) are one of the North American species of chelonians that meet the concern of poor recruitment. Programs throughout their range have been established to help conserve local populations. While there are obvious benefits to this type of program, it is not without risk. Chelonians are known to serve as reservoirs for a number of pathogens. How these pathogens act can be influenced by the environment in which they are found. The purpose of this study was to determine the prevalence of *Salmonella* in captive hatched Blanding's turtles from a head-start program in Illinois. One-hundred and twenty Blanding's turtles from three different cohorts were sampled in this study. Culture samples were collected and processed using standard techniques. *Salmonella* was not isolated (0/120, 95% Confidence Interval: 0-2.5%) from this population. Instead, the most common isolates from these animals were *Citrobacter braakii*, *C. freundii*, and *Enterobacter cloacae*. All of these organisms are potentially zoonotic. Evaluating the antibiotic sensitivity profiles of the isolates suggests that the turtles leaving this head start program are unlikely to disseminate microbes with a negative impact on the environment.

EPIDEMIOLOGY OF MARINE TURTLE DISEASE AND MORTALITY IN SOUTHERN QUEENSLAND, AUSTRALIA

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Abstract

Causes of disease and mortality in marine turtles are poorly understood. Over a 4-yr period (2006-2009), the major anomalies in blood variables and causes of stranding in green turtles (*Chelonia mydas*) from southern Queensland, eastern Australia, were determined. After establishing baseline values for blood variables using healthy turtles (n = 211), clinically unhealthy turtles (those in poor body condition, displaying clinical abnormalities and/or having a history or current presentation of fibropapillomatosis; n = 25) had blood variables outside of the reference intervals: albumin, 48% of unhealthy animals; alkaline phosphatase, 35%; aspartate transaminase, 13%; creatinine, 30%; globulin, 3%; glucose, 34%; lactic dehydrogenase, 26%; phosphorus, 22%; sodium, 13%; thrombocytes, 57%; and monocytes, 5%. Blood variables suggested abnormal function of cardiovascular, renal, hepatic and/or gastrointestinal systems.[1] Primary causes of mortality in stranded turtles (n = 100) were diagnosed as spirorchiidiasis (41.8%), gastrointestinal impaction (11.8%), microbiologic infectious diseases (5.2%) and trauma (5.2%). Minor contributors to mortality (36%) included multiple diffuse pathologies, respiratory, other parasitic infections, neurologic, excretory, urogenital and skeletal pathology.[2] Spirorchiidiasis had (i) more observed cases of infection in summer compared with other seasons (P = 0.029) and (ii) immature turtles had more severe pathology than mature turtles (P = 0.032). Number of observed cases and severity of spirorchiid lesions were highest in the brain compared with heart, gastrointestinal tract and spleen (all $P > 0.1$).[2] To link findings, further investigation is required, including the examination of the role of water quality and urbanization in potentiating these syndromes.

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DISEASE INCIDENCE ASSOCIATED WITH STRANDED SEA TURTLES TRIAGED AT TARONGA WILDLIFE HOSPITAL: A RETROSPECTIVE STUDY

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Abstract

Retrospective analysis (1985 – 2010) was performed to assess the disease status and eventual fate of 189 sea turtles triaged at the Taronga Wildlife Hospital (TWH). Sea turtles admitted to the hospital represented four of 6 species found in Australian waters: green turtle (*Chelonia mydas*) n=131, hawksbill turtle (*Eretmochelys imbricata*) n=30, loggerhead turtle (*Caretta caretta*) n= 16 and flatback turtle (*Natator depressus*) n=12. Significant increases in sea turtle admissions have occurred since the mid-1980's, which averaged two cases per year without release success. Since the mid-1990's, four species have been represented, averaging 15 cases per year with a release success nearing 13%. Release success has continued to increase to an average of 26% through the 2000's. Major reasons for presentation include: trauma 27% (including boat strike, fishing gear entanglement, power plant entrapment), infectious disease 16%, impaction 12% (including plastic/foreign bodies), parasitism 10% and emaciation 5%. It is important to note that an epizootic systemic coccidiosis (*Caryospora cheloniae*) event of adult green turtles in 2002 accounted for a majority of the parasitism cases.[1] In addition to clinical pathology, radiographs are critical diagnostic tools for disease diagnosis and useful prognostic indicators for rehabilitation success, particularly in cases of trauma, fishing hook ingestion, and pneumonia. Most critically, all sub-adult turtles with evident obstipation on radiographs have not been successfully rehabilitated. A further component of this study is to also correlate clinical findings (clinical pathology, radiographic changes) with necropsy findings in animals that died or were euthanatized.

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DETECTION OF KEY FACTORS IN THE DEVELOPMENT OF FIBROPAPILLOMAS IN GREEN SEA TURTLES (*Chelonia mydas*); CULEBRA, PUERTO RICO

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Abstract

Fibropapillomatosis is a disease of sea turtles characterized by the development of wart-like tumors on the skin, eyes, mouth, cloaca, and frequently fibromatous masses in visceral organs.[1,2] This disease is linked to the chelonid fibropapilloma-associated herpesvirus (CFPHV).[3,4] Cutaneous fibropapillomatosis in green turtles is a multifactoral neoplastic disease where an infectious agent, the environment, host immune system and possibly genetics act in synergy. The Culebra archipelago provides an ideal setting where clinical data in free-ranging animals from an endemic focus can be followed over a long term. Over the last 5 yr we have been collecting health assessment data (physical examinations, hematology, plasma biochemical analysis, plasma protein electrophoresis, coelomic and ocular ultrasonograms) and testing for CFPHV via PCR in healthy and affected animals to create baseline parameters for this population. Additionally, we have surgically removed tumors from a selected group of individuals and are monitoring the effects of early surgical excision on remission rate versus spontaneous resolution of disease. These studies are performed in conjunction with ongoing population biology studies by the Puerto Rico Department of Natural and Environmental Resources (PR-DNER). Our goal is to create baseline parameters of health assessments, determine groups' heterogeneity and dispersal, and provide significant insight into the pathogenesis of the disease in the wild through the use of long-term capture and release surveys, correlating clinical findings such as immune response, spontaneous tumor regression, post-surgical recurrence, and visceral metastasis; with molecular pathology studies (riboprobe in situ hybridization and immunohistochemistry).

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ENDOCRINE RESPONSES TO NATURAL AND ANTHROPOGENIC STRESSORS IN LEATHERBACK TURTLES (*Dermochelys coriacea*) AND KEMP'S RIDLEY TURTLES (*Lepidochelys kempii*)

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Abstract

Plasma corticosterone (B) and free thyroxine (fT4) concentrations were assessed in frozen (-80C) archived samples from leatherback (*Dermochelys coriacea*) and Kemp's ridley turtles (*Lepidochelys kempii*). Samples were obtained from leatherbacks that were entangled in fishing gear (n=8) or captured directly as part of an ecology and health study (n=10); and from Kemp's ridleys hospitalized after natural cold-stunning events (n=87 samples, 57 turtles). Corticosterone was measured using a double-antibody 125-I radioimmunoassay kit, and fT4 with a coated-tube 125-I radioimmunoassay kit (MP Biomedicals, Orangeburg, NY). Parallelism and accuracy validation were successful. Entangled leatherbacks had higher B and fT4 than directly captured leatherbacks (entangled: B = 10.2 ± 6.6 ng/ml, fT4 = 1.67 ± 0.68 pg/ml; captured: B = 4.7 ± 2.5 ng/ml, fT4 =0.10 ± 0.10 pg/ml; p=0.045 for B, p=0.01 for fT4, t-tests). Kemp's ridleys sampled within 3 days of admission tended to have high B and low fT4, with no significant difference between turtles that survived vs. those that died (survived, B = 38.53 ± 3.95 ng/ml, fT4 = 0.10 ± 0.05 pg/ml; died, B = 39.95 ± 3.19 pg/ml, fT4 = 0.09 ± 0.21 pg/ml; p>0.05, t-tests). After 3 wk of convalescence, Kemp's ridleys showed a decrease in B and increase in fT4 (B= 0.81 ± 0.19 ng/ml; fT4 = 1.30 ± 0.34 pg/ml; p<0.01, t-tests). These data provide insight into the endocrine responses of sea turtles to a variety of stressors, and may be clinically useful for monitoring the convalescence of hospitalized sea turtles. (Data shown=mean ± SEM)

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PREVALENCE AND DISTRIBUTION OF LUNG RADIOGRAPHIC ABNORMALITIES IN COLD STUNNED KEMP'S RIDLEY SEA TURTLES (*Lepidochelys kempii*): 102 CASES

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Abstract

A retrospective radiographic survey was performed on 102 cases of cold stunned juvenile Kemp's ridley sea turtles from Cape Cod, MA (2001-2005). Dorsoventral and craniocaudal horizontal beam radiographs were evaluated for lung abnormalities. Results showed a significantly higher prevalence for right sided lung radiographic abnormalities. A total of 26% of sea turtles had radiographic changes which were either predominantly on the right side or mostly on the right lung field, versus 4% of the turtles who had radiographic abnormalities that was either left sided only or predominantly on the left side. The greater prevalence of right side lung lesions has not been previously described in sea turtles, and the reasons for this finding are unclear. The etiology of pneumonia in cold-stunned sea turtles has been discussed and debated over the last several decades by wildlife rehabilitators. It is possible that the relatively ventral position of the right bronchus, compared to the left bronchus, makes aspiration of sea water into the right lung more likely. This may have clinical relevance, such as directing bronchoscopic sampling at the right lung for diagnosis and treatment of pneumonia in this endangered species.

FLORIDA'S 2010 COLD STUNNED SEA TURTLES

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Abstract

An extended period of frigid temperatures resulted in an unusually high number of sea turtle strandings in January 2010 in Florida. Over 4500 sea turtles stranded over the course of 3 wk; 80% of these stranded alive. In the early stages of the event, rehabilitation seemed feasible for all live strandings. Cases were distributed by Florida Fish & Wildlife Conservation Commission (FFWCC) over 13 rehabilitation facilities in South and Central Florida. These facilities were at capacity in early January, before the peak of the cold stun hit. A triage system utilizing physical exam and patient side blood work via the I-STAT was developed to filter the animals with mild abnormalities requiring minimal intervention ("treat and street") from those requiring more extensive hospital stays and medical or surgical management. Core blood values including HCT, TS, blood glucose, pH and ionized calcium were obtained. Animals held back had a variety of maladies ranging from electrolyte disturbances, corneal injury, shark-bites, motor craft injury, eyelid trauma due to pecking by birds, and fibropapilloma (FP) tumors. A large number of FP turtles were suffering complications before the cold stunning. These patients already were anemic, malnourished, had widespread tumor necrosis, and rampant infection. All released turtles were given a visible flipper tag and PIT tag to ensure that any wash-backs would be identified as such. Stranding numbers have remained uncommonly high for the remainder of the year with many turtles that endured the weeks of cold temperatures stranding weeks to months later in critically debilitated condition.

PLASMA BIOCHEMISTRY AND HEMATOLOGY VALUES IN JUVENILE HAWKSBILL TURLES (*Eretmochelys imbricata*) UNDERGOING REHABILITATION

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Abstract

The hawksbill turtle (*Eretmochelys imbricata*) is one of five species of sea turtle found in the Arabian Gulf, and along with the green turtle, is one of only two species that regularly nests in the region. All sea turtles are included in the IUCN red list and the hawksbill is listed as critically endangered. They face extensive threats from such human impacts as pollution, coastal development and fishery practices. If these hazards continue at their present rate, the sea turtle population of the Arabian Gulf could be jeopardized. As a conservation group, the Dubai Turtle Rehabilitation Project aims to rescue, study, and treat injured sea turtles in order to release them back to their natural habitat. Blood tests taken from juvenile hawksbills during convalescence and prior to release, have been correlated, establishing hematology[1,2,3] and biochemistry[4] reference ranges for juvenile hawksbills of the Arabian Gulf. Hemoglobin (B-Hemoglobin Photometer Hemocue AB, Angelhom Sweden), PCV, WBC (1% ammonium oxalate solution stain) and AST, CK, UA, GLU, Ca, PHOS, TP, ALB, GLOB, K, Na (Abaxis VetScan Classic Analyzer, Germany) are the parameters investigated.

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MEDICAL AND SURGICAL MANAGEMENT OF AUTOMOBILE AND BOAT STRIKE TRAUMA IN DIAMONDBACK TERRAPINS AND MARINE TURTLES

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Abstract

Twenty to 30% of sea turtles stranding in coastal Georgia have some evidence of boat strike injuries. Many survive some very significant trauma and are presented to the Georgia Sea Turtle Center for rehabilitation. Approximately 300 Diamondback terrapins (*Malaclemys terrapin carolina*) are hit by automobiles annually on the Jekyll Island causeway. Innovative wound care techniques have been developed for these injuries. Attention must be paid to emergency care, development of a prognosis, diagnostic testing and supportive care for turtles presenting with significant wounds. Principles of wound care that are utilized on other species should be followed. Topical placement of bone cement with antibiotics and doxirobe gel (Pharmacia & Upjohn Company, Kalamazoo, MI 49001, USA), honey, honey comb, Medi-honey (Derma Sciences from New Zealand, Toronto, Ontario MIS 3S4) and a variety of silver based products have proven useful in managing these wounds. Petroleum impregnated gauze, Steristrips (3M, St. Paul, MN 55144 USA), Tegaderm dressing (3M, St Paul, MN 55144 USA), superglue, and water proof tape have all been used to cover and water proof various wounds. In areas that are difficult to bandage, suture loops and umbilical tape can be used to keep medication and packing material in place. A modified Vacuum Assisted Wound care protocol has been successfully used for some wounds. The turtle must be out of the water during the treatment, thus a combination VAC therapy with other modalities are typically used.

EDUCATION OUTREACH, RESEARCH, AND MANAGEMENT STRATEGIES UTILIZED BY THE GEORGIA SEA TURTLE CENTER TO REDUCE MORTALITY FROM BOAT STRIKE INJURIES IN MARINE TURTLES AND AUTOMOBILE COLLISIONS IN DIAMONDBACK TERRAPINS IN COASTAL GEORGIA

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Abstract

Boat strike injuries cause significant morbidity and mortality in marine turtles and is increasing in frequency worldwide. Automobile related morbidity and mortality is significantly affecting diamondback terrapin populations throughout their range. Nearly a quarter of a million people have had the opportunity to learn about sea turtles and diamondback terrapins though the interactive educational exhibits and programs at the Georgia Sea Turtle Center (GSTC) since its opening 3 yr ago. Visitors can view patients and various procedures through an exhibit gallery window and an elevated walkway that divides the hospital tanks in the rehabilitation area. Regular patient updates are presented by educators that focus on the medical issues pertaining to individual patients, but more importantly discuss the population effects of the various threats and what the average person can do to help. The staff conducts regular educational outreach program for schools. Professional training is available through an Americorp program, veterinary technician and veterinary student externships, and graduate student research projects. Examples of conservation programs include placing terrapin crossing signs on the causeway during the nesting season; egg extraction from dead female terrapins hit by car for incubation, hatching and rearing for release; working with the Department of Transportation to minimize mowing and tilling on the causeway during the terrapin nesting and hatching season; documenting the level of mortality; defining hot spots for nesting and mortality; placing artificial nest mounds with raccoon proof caging on top in strategic locations along the causeway; permanently identifying terrapins; and development of collaborative research programs.

CLINICAL MANAGEMENT OF CLOACAL PROLAPSE IN AN ADULT GALAPAGOS TORTOISE (*Geochelone nigra*)

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Abstract

An intact female >80-yr-old, 105-kg Galapagos tortoise (*Geochelone nigra*) was evaluated for cloacal prolapse of 3-wk duration. Physical examination revealed prolapsed, edematous, pink, cloacal and clitoral tissue. The tortoise was sedated with morphine (0.5 mg/kg, i.m.) and midazolam (0.3 mg/kg i.m.) and the tissue was reduced after hypertonic sugar solution, DMSO and lidocaine/bupivicaine application. Initial reduction was followed by transverse sutures to reduce the size of the cloacal opening. The tissue re-prolapsed two days later. Over 6 wk, multiple methods of reduction were attempted. These included cloacopexy, cloacal stinting, placement of absorbent pressure bandage, purse-string closure and profound sedation, but all were unsuccessful. During this time, an indwelling sub-dural 24-gauge catheter was placed and used to administer analgesia and paralytics to prevent straining. Although this stopped the tenesmus, a 4-cm section of cloacal tissue was persistently swollen and prolapsed. This 4 cm of tissue was surgically amputated using a linear surgical TA 90 stapler. One week after amputation, the area was imaged using endoscopy and appeared to be healing normally. In the months following surgical amputation, the tortoise had no recurrence of cloacal prolapse.

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STERILIZATION OF HYBRID GALAPAGOS TORTOISES (*Geochelone nigra*) FOR ISLAND RESTORATION: PART 1 FEMALE ENDOSCOPIC OOPHORECTOMY UNDER KETAMINE – MEDETOMIDINE ANESTHESIA

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Abstract

Oophorectomy has traditionally been performed through a plastron osteotomy or prefemoral coeliotomy.[1,3] Plastron osteotomy is typically a longer, more traumatic and invasive procedure than a soft tissue, prefemoral approach. Prefemoral coeliotomy offers limited visualization of viscera compared to plastron osteotomy; however, an endoscope-assisted oophorectomy technique has recently been described for small species of Chelonia, and offers a minimally invasive approach with improved visualization and accessibility.[2] The aim of this study was to further develop the endoscopic technique to permit sterilization of giant chelonians. An endoscopic sterilization technique was developed in 15 female giant Galapagos tortoises (*Geochelone nigra*) as part of a conservation and ecosystem restoration project. A bilateral prefemoral approach was made and the ovaries were identified using a 5 mm x 33 cm rigid telescope. In the case of endoscope-assisted oophorectomy, the ovaries were exteriorized though the same incision, the vasculature was ligated, and the mesovarium transected. Two tortoises had immature ovaries which were unable to be exteriorized. In these animals endoscopic oophorectomy was performed using radiosurgery. Closure of the incisions was routine. All tortoises except one recovered well from surgery. There were no reported complications 6 wk post-operatively. These results suggest that endoscopic and endoscopic-assisted oophorectomy are safe and practical techniques to sterilize or treat reproductive disorders in large chelonian species. These techniques minimize anesthesia, surgery, and recovery times, and have few post-operative complications. This study also demonstrated that the described techniques are easily accomplished either in the clinic or in a field setting, and have potential applications for immature as well as sexually mature chelonians.

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CLINICO-PATHOLOGIC FEATURES OF CUTANEOUS MELANOMA IN SNAKES

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Abstract

Melanoma (chromatophoroma) is a pigmented tumor arising from the chromatophores of the skin and epidermis. Isolated cases have been reported in snakes, but large retrospective studies have not been done. This report describes the clinico-pathologic features of melanomas in snakes submitted to a specialty diagnostic service. From November, 1994-April, 2010, 4663 snakes were submitted to Northwest ZooPath, including 54 melanoma submissions representing 35 species. Affected snakes included 29 colubrids, 15 vipers, and 13 boids. Of these, four were repeat biopsies and five were follow-up necropsies (relative prevalence = 46/4663 = 1.0 %). San Francisco garter snakes (*Thamnophis sirtalis tetrataenia*) were the most commonly represented species (4). Five snakes died, seven were euthanatized, and disposition was unknown for 34. All tumors were initially diagnosed from skin biopsies, and were described as solitary or multiple white, yellow, brown or black, solid or cystic lesions from the dorsum (11), side (8), ventrum (9) or unknown location (22). Age ranged from 2-27 yr and average age was 14 yr, but age was unknown for 16 adults. No sex predilection was noted. None of the snakes were reported as clinically ill at the time of initial biopsy. Twenty eight tumors were incompletely excised at first biopsy, three at second biopsy, and seven were euthanatized due to recurrence at the surgical site or regional skin. Survival after initial histologic diagnosis was known for nine snakes, ranged from 2 to 118 mo with average of 24 mo, and metastasis was noted in seven of these snakes. Two biopsied tumors had evidence of vascular invasion, and histologic evidence of visceral metastasis was noted in 11/16. Well differentiated and anaplastic, poorly differentiated tumors had metastatic behavior. Regardless of cell morphology and degree of differentiation, cutaneous melanomas in snakes should be considered malignant with potential for local tissue invasion and visceral metastasis, although survival time after initial diagnosis may be relatively long compared to that of malignant melanoma in other Classes.

INVESTIGATION OF METASTATIC SOFT TISSUE MINERALIZATION IN CAPTIVE KOMODO DRAGONS (*Varanus komodoensis*)

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Abstract

Metastatic soft tissue mineralization has emerged as a major risk factor for mortality in captive Komodo dragons (*Varanus komodoensis*), having been reported in approximately 30% of mortalities over the last 20 yr. A histologic review indicated that metastatic mineralization contributed to the cause of death in approximately half of these cases, and suggested it may be linked to the high prevalence of yolk coelomitis and/or embolization in females. A comprehensive institutional survey analyzed current diet and husbandry practices for captive Komodo dragons in North America. Twenty-one institutions participated in the survey, which managed a total of 53 animals. There were 26 (49.1%) males, 20 females (37.7%), and 7 (13.2%) unknown sex dragons included in the survey. The median age of the animals was 10.1 yr (minimum-maximum: 0.33-21.7 yr). A total of 16 mortalities were recorded by the institutions. The majority (81%; 13/16) of the deaths were reported in females, and the mean age at death was 10.0 yr (SD: 6.4, minimum-maximum: 0-21). The majority (69.2%; 9/13) of the deaths in females were attributed to metastatic mineralization and yolk coelomitis. The other deaths were attributed to cervical cord compression, liver disease, sepsis, trauma, and dystocia. Participating institutions varied in the husbandry methods they provided their dragons, whether it be temperature gradients, indoor/outdoor exposures (majority of the dragons had the opportunity to move between indoor and outdoor habitats), types of artificial light provided, or diet (rats, rabbits, quail, chicken, fish, eggs and commercial bird of prey diets).

EVALUATION OF THE HISTOLOGIC REACTIONS TO COMMONLY USED SUTURE MATERIALS IN BALL PYTHONS (*Python regius*)

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Abstract

Tissue reaction to suture materials has been studied in several non domestic species,[1-4] but only a single short term study exists in reptiles.[2] We evaluated the histologic reaction to eight different suture materials and cyanoacrylate tissue adhesive over a period of 90 days in 30 hatchling ball pythons. Ten incisions were made in each snake and sutures were placed in the muscle and skin using PDS, PDS plus, Monocryl, Monocryl plus, Vicryl, chromic gut, Ethilon, and stainless steel. One incision was closed using cyanoacrylate tissue adhesive and the last incision was left to heal by second intention and act as a negative control. Snakes were euthanatized at 3, 7, 14, 30, 60, and 90 days following suture implantation and histologic reaction to the suture was evaluated. All suture materials caused significantly more inflammation than the negative control. Cyanoacrylate tissue adhesive did not cause a significant tissue reaction compared to the negative control. All suture types were intact 90 days following implantation and caused a chronic inflammatory response and granuloma formation. In several samples the granulomas appeared to be contiguous with the skin and the suture appeared to be in the process of being extruded from the underlying tissues. Due to prolonged absorption compared to published data in mammals some suture may undergo extrusion prior to complete absorption.

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HYPERTHYROIDISM IN A LEOPARD GECKO (*Eublepharis macularius*) AND RADIOIODINE (I-131) TREATMENT

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Abstract

Hyperthyroidism was diagnosed in a 14-yr-old intact female leopard gecko, *Eublepharis macularius*, with clinical signs of anorexia, diarrhea and shedding more frequently than normal. Diagnostic workup was unremarkable except total thyroxine (T_4), by radioimmunoassay, which was 20.59 nmol/L, which was elevated compared to normal snake (0.21-6.06 nmol/L) and iguana (2.97 – 4.65 nmol/L) values. A repeat T_4 5 wk later was 64.35 nmol/L. Normal total T_4 values on 6 unrelated leopard geckos ranged from 6.05-19.31 nmol/L with a mean of 12.48 nmol/L. A spect computed tomographic (CT) technetium scan (1 mCi injected intracoelomically, scanned at 15 min) using a pin hole collimator revealed two discreet symmetric foci of activity in the ventral cervical soft tissue of a control leopard gecko, compared to a unilateral midline cervical mass, consistent with an enlarged thyroid gland, and no second focus of activity, in the patient. Spect CT findings were consistent with a unilateral thyroid gland enlargement resulting in negative feedback and suppression of the contralateral thyroid gland. Iodine-131 (0.1 mCi) was injected subcutaneously in the ventral neck, thyroid values at 1 mo (14.16 nmol/L), 3 mo (6.44 nmol/L) and 5 mo (12.61 nmol/L) were normal compared to other leopard geckos. Diarrhea resolved post-treatment; the gecko resumed feeding and gained weight.

DETERMINATION OF SELECT PLASMA VITAMIN CONCENTRATIONS AND BONE DENSITY IN WILD CAUGHT BULLFROGS (*Lithobates catesbeianus*)

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Abstract

Six wild caught bullfrogs (*Lithobates catesbeianus*) were evaluated for captivity effects, using a repeated measures design, on select serum vitamin concentrations and bone mineral density. Frogs were captured from a local pond in June and blood was collected for determination of serum vitamin A and D_3 concentrations. In addition bone density was evaluated through radiographs, and Bone Mineral Density (BMD), was determined using a bone densitometer. All frogs had passive integrated transponder (PIT) tags placed in the ceolomic cavity for identification and then released back into the same pond. The same frogs were captured in September and all the above data were again collected on each frog. At this time all frogs were retained in captivity under current Zoo Atlanta husbandry protocols for the species. Frogs were evaluated as above every 3 mo to monitor captive effects on vitamin concentrations and BMD. Wild frogs were captured during the active season, (starting at T_3), for comparison to captive animals. Bone Mineral Density (g/cm^2) at time zero (T_0) was as follows: spine (mean 0.17; range 0.01-0.23; standard deviation 0.05), right and left femurs (0.13; 0.10-0.16; 0.02) and right and left tibias (0.18; 0.14-0.21; 0.03). The mean change in BMD from T_0 to T_1 (3 mo in captivity) was as follows: Spine - 1.63%; femurs + 0.39%; tibias + 2.9% and from T_0 to T_2 (6 mo in captivity) was: Spine – 12.84% (significant); femurs -2.09% and tibias – 4.63%. Wild frogs had greater BMD compared to captive frogs at T_3 (late April): spine (wild 0.19, captive 0.14, % difference +26.3); femurs (0.15, 0.13, + 13.3); tibias (0.21, 0.17, +19.0)

Similar data for serum concentrations of vitamin A and vitamin D_3 were collected. Serum vitamin D_3 (nmol/L) and vitamin A (ng/ml) concentrations (mean and range) respectively, for late spring and early summer, (T_0) from wild caught frogs were 33.2 (13-59) and 483.7 (364-623) and for late summer wild caught frogs (T_1) values were 27 (11-50) and 16.8 (5-33). Wild caught frogs sampled at (T_3) had serum values of 50 and 114 respectively. Captive frog values for 3 mo in captivity (T_2) were 12.2 (7-18) and 202 (111-272) and for 6 mo in captivity (T_3) were 21 (17-32) and 78.2 (49-111). Final interpretation of the data will performed after statistical analysis is complete at the end of the 12-mo study.

HISTOPATHOLOGIC INVESTIGATION OF POST-TREATMENT VITAMIN-A DEPLETED AFRICAN FOAM NESTING FROGS (*Chiromantis xerampelina*)

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Abstract

Vitamin A is essential for the maintenance of normal epithelium, glandular and immune function, development and metamorphosis in amphibians. Over-supplementation, however, can be detrimental, affecting the hepatobiliary, reproductive and skeletal systems in mammals and birds and the integumentary system of reptiles. The results of experimental vitamin A supplementation in a captive population of African foam nesting frogs (*Chiromantis xerampelina*) known to be vitamin A deficient were previously reported.[1] The current study investigates the histopathology of these experimentally supplemented animals, with an emphasis on lesions attributable to vitamin A-induced toxicity and those associated with hypovitaminosis A post-treatment. Experimental supplementation consisted of a control group receiving a diet containing 342,000 IU/kg of vitamin A and three treatment groups consisting of: 1) increased dietary vitamin A (822,510 IU/kg), 2) topical administration of approximately 50 IU of vitamin A palmitate every other day, and 3) topical administration of approximately 50 IU of vitamin A palmitate once weekly. Both of the groups given topical vitamin A were also fed the control diet. Histopathologic examination of these animals did not identify any lesions attributable to hypervitaminosis A. Squamous metaplasia of the urinary bladder mucosal epithelium, presumed to be a residual lesion of hypovitaminosis A, was present in varying degrees only in the control group (lower nutritional levels) and those given weekly topical vitamin A (group 3). These findings indicate that vitamin A administration at the above dosages does not result in histopathologic lesions associated with vitamin A toxicity. Increased oral supplementation and every other day topical administration may be the most effective methods of reversing hypovitaminosis A-induced lesions.

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TISSUE CONCENTRATIONS OF ENROFLOXACIN, AND ITS METABOLITE CIPROFLOXACIN, AFTER A SINGLE TOPICAL DOSE IN THE COQUI FROG (*Eleutherodactylus coqui*)

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Abstract

There are few studies evaluating transcutaneous absorption of antibiotics in amphibians.[4-7] This study determined tissue concentrations of the fluoroquinolone antimicrobial enrofloxacin, and its active metabolite ciprofloxacin, over a 24-hr period after a single topical application in coqui frogs, *Eleutherodactylus coqui*. Twelve frogs, scheduled for euthanasia unrelated to the study, were randomly divided into four groups of three animals. Three groups received one dose of enrofloxacin topically (10 mg/kg), while the remaining group served as an untreated control. One group was euthanatized and liver and kidneys were collected at 0 (control), 6, 12, and 24 hr post-treatment. Tissues were pooled per group and concentrations of enrofloxacin and ciprofloxacin were measured using high pressure liquid chromatography. Enrofloxacin tissue concentrations ranged from 0.2 to 0.44 μg/g, which is below the minimum inhibitory concentration (MIC) for susceptible organisms (0.5 μg/mL).[1] Ciprofloxacin concentrations ranged from 0.42 μg/g to 0.81 μg/g, which is also below the MIC for susceptible organisms (1.0 μg/mL).[1] Susceptibility levels have not been established for amphibian bacteria, therefore, MIC levels are based on plasma concentrations in domestic species.[1] In vitro studies demonstrate an additive effect of enrofloxacin and ciprofloxacin concentrations for improved bacterial inhibition.[3] The sum of enrofloxacin and ciprofloxacin in this study range from 0.78 ug/g to 1.25 ug/g, though it is not known how tissue concentrations correlate with therapeutic efficacy.[1] Results of this study indicate that enrofloxacin is absorbed systemically following topical administration in coqui frogs, converts to ciprofloxacin, and measurable tissue concentrations are present for at least 24 hr.

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AMYLOIDOSIS IN PYGMY MARMOSETS (*Callithrix pygmaea*)

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Abstract

Systemic or reactive (AA) amyloidosis has been reported in several species of captive primates including pig-tailed macaques (*Macaca nemestrina*), chimpanzees (*Pan troglodytes*) and common marmosets (*Callithrix jacchus*).[1-3] Amyloidosis has also been previously documented as a post-mortem finding in the pygmy marmoset (*Callithrix pygmaea*) and is often associated with chronic inflammatory disease.[4]

A retrospective survey of pygmy marmoset necropsies submitted to Northwest ZooPath from 1995-2009 revealed that 38.3% (31/81) of animals older than 2 wk of age had histologic evidence of amyloid in one or more organs. An additional nine cases were identified via survey of individual zoological institutions. The most commonly affected organs were the liver, spleen, and kidneys with amyloid deposition in 90.0%, 72.5%, and 52.5% of cases respectively. Additional organs affected included adrenals, gastrointestinal tract, lung, heart, lymph nodes, pancreas, skin, and vasculature. The ages of affected animals ranged from 1-17.6 yr, with a mean age of 7.9 yr. No sex predilection was observed. The majority of cases had multiple concurrent chronic disease processes including cardiac, renal, or inflammatory gastrointestinal disease. Only two marmosets had a pre-mortem diagnosis of amyloidosis via hepatic biopsy.

Based on the results of this survey, amyloidosis is a common postmortem finding in captive pygmy marmosets and can be a significant contributing factor in mortality of this species. Further investigation is needed to determine if genetic factors play a role in susceptibility and if earlier diagnosis and treatment of concurrent diseases can limit or prevent progression of systemic amyloidosis.

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HYPERGLYCEMIC EFFECTS OF ALPHA-TWO ADRENERGIC AGONISTS DURING IMMOBILIZATION OF FREE-RANGING RING-TAIL LEMURS (*Lemur catta*)

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Abstract

Diabetes mellitus is an emerging problem in captive ring-tailed lemurs (*Lemur catta*),[4] so it is important to know normal blood glucose values when ring-tailed lemurs are anesthetized and to determine whether any drug effects could cause changes in blood glucose values. Induction with Telazol® and supplementation with medetomidine-butorphanol was shown to be a highly effective protocol for anesthetizing free-ranging ring-tailed lemurs.[2] Alpha-two adrenergic agonists, such as medetomidine, are known to cause hyperglycemia in some species,[1,3] but other factors, such as stress, may also cause transient hyperglycemia. This study aimed to determine glucose values in free-ranging ring-tailed lemurs, both before, and after, alpha-two agonist administration. Medetomidine-butorphanol supplementation was also compared with dexmedetomidine-butorphanol supplementation due to decreasing commercial access to medetomidine.

Lemurs (n = 32) were anesthetized with Telazol® administered via Daninject® blow dart. Once recumbent, they were supplemented via hand-injection with either medetomidine (0.05 mg/kg) and butorphanol (0.25 mg/kg) (n = 16) or dexmedetomidine (0.025 mg/kg) and butorphanol (0.25 mg/kg) (n = 18). Blood samples were taken from the external saphenous vein immediately before supplementation and 10 min post-supplementation. Initial glucose values varied widely (173 $\pm$ 106 mg/dl; min-max = 75-540 mg/dl). Four lemurs, two in each group, had decreases in blood glucose post-supplementation, but 28 had increases in glucose post-supplementation. Of those with post-supplementation increases, the lemurs receiving medetomidine had increases of 69 $\pm$ 59 mg/dl (min-max = 7-217 mg/dl), while those that received dexmedetomidine had increases of 107 $\pm$ 60 mg/dl (min-max = 56-287 mg/dl).

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EXAMINATION OF *Campylobacter* AND *Escherichia coli* POPULATIONS IN A CAPTIVE ZOOLOGICAL COLLECTION OF NON-HUMAN PRIMATES

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Abstract

Chronic enterocolitis in captive primates has long been a problem in both zoo settings and research colonies. The most common clinical symptom observed with chronic enterocolitis is diarrhea, making it a public health concern as well as an animal health and welfare concern. Management of chronic enterocolitis is confounded by its complexities, including the lack of a consistently identifiable causative agent.

A pilot study was performed during the summer of 2009 in collaboration with a local zoo in Saint Paul, MN, which was experiencing an increased incidence and severity of diarrhea among it's non-human primate collection. Fecal samples were collected on a weekly basis from 33 animals representing 8 different species within the primate collection and *Campylobacter* and *Escherichia coli* were isolated using previously published techniques. We recorded the fecal consistency of each sample, noting when abnormally watery diarrhea or bloody diarrhea occurred.

Overall, there was a gross correlation between *Campylobacter* prevalence within an animal and a history of diarrhea. However, the strains were not clonal and from multiple *Campylobacter* species, suggesting this correlation was not absolute and did not involve a single causative species or clonal type. In addition, suspect *E. coli* were assessed for phylotype, genotype and drug susceptibility and these data were combined with observational data in an effort to identify risk factors associated with chronic enterocolitis. Overall, results suggest that the manifestation of colitis in non-human primate collections is indeed complex and likely involves multiple microbial agents in combination with environmental causes.

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COMPUTED TOMOGRAPHIC EVALUATION OF THE UPPER RESPIRATORY TRACT OF ORANGUTANS (*Pongo s*pp.)

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Abstract

Captive orangutans (*Pongo pygmaeus, Pongo abelii*) often suffer from upper respiratory tract diseases such as the common cold, sinusitis or airsacculitis. While the diagnosis of airsacculitis is facilitated by obvious clinical signs, diagnosis of sinusitis is difficult and requires advanced imaging tools. The present study describes the use of computed tomography (CT) to compare the normal anatomy to the appearance of upper respiratory tract disease in orangutans.

For sinus evaluation in the orangutan, a high resolution CT scanning technique is recommended with a slice thickness < 0.75mm and a slight overlap reconstruction. Image evaluation is recommended in the coronal plane and with a bone window set at the width of 1500 HU and the level of 300 HU. In the CT images, two paranasal sinuses were identified, which drain through recognizable ostia into the middle meatus and upper meatus of the nasal cavity. Using computed tomography, orangutans with a history of upper respiratory tract disease had numerous alterations within the sinuses. Alterations included thickened mucosal membranes, severe bone destruction and fluid or pus-filled sinuses. All currently examined animals with airsacculitis also had a sinusitis, suggesting a possible relationship between these two diseases (e.g. sinusitis may be a predisposing factor for airsacculitis).

The current data suggests that CT scanning of the head represents an advanced imaging technique for early diagnosis of upper airway diseases in orangutans, and thus might allow the initiation of treatment to prevent complications such as airsacculitis.

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A REVIEW OF REPRODUCTIVE MEDICAL CONDITIONS IN A COLLECTION OF CAPTIVE BONOBOS (*Pan paniscus*)

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Abstract

Reproductive management of the captive bonobo population entails thorough knowledge of medical conditions affecting this species. The medical records of 28 (9 males, 19 females) bonobos ranging in age from 10 mo to 60 yr at the Milwaukee County Zoo from 1986 to the present were reviewed. Reproductive conditions in males were rare, but included prostate-related disease in two animals. Reproductive problems in females had a broader range and could be categorized as pregnancy-related conditions, issues related to contraceptive management, reproductive tract abnormalities or trauma. The most numerous reports were pregnancy-related, including abruptio placenta with subsequent death of the dam and fetus, pre-eclampsia and placental insufficiency with resultant low-weight infant, spontaneous abortion, and blighted ova identified through repetitive reproductive sonograms. Contraceptive-associated problems included breakthrough bleeding while on lower estrogen dose oral birth control pills. Reproductive tract abnormalities included two cases of trauma to the external genitalia and one case of suspected uterine fibroids.

Bonobos appear relatively robust reproductively. The number of abnormal reproductive problems was low over the 24 yr of records reviewed. Early pregnancy detection through urine hormone testing with subsequent repetitive reproductive sonograms allows monitoring of the fetus and placenta for abnormalities, and provides for estimation of gestational age and parturition date.[1,2]

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EVALUATION OF CAPTIVE GIBBONS FOR AN EPIZOONOTIC AGENT: THE GIBBON APE LEUKEMIA VIRUS (GALV)

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Abstract

The gibbon ape leukemia virus (GALV) is an infectious gammaretrovirus associated with neoplasias in gibbons. Highly related retroviruses have been isolated from other animals (woolly monkey, koalas).[1-4] The virus is shed in urine, feces, and saliva, and can be transmitted *in utero* and via postnatal contact. Since its initial characterization in the 1970's and 80's, the incidence of GALV has not been assessed in gibbons. Investigating the disease status of captive animals as well as factors affecting their health is a critical first step in determining if captive gibbons are infected, and if an etiologic linkage between infection and neoplastic diseases exists. Three diagnostic assays (ELISA, Western blot, and PCR) were used to identify the presence or absence of GALV antibodies, viral proteins, and infection status in five captive gibbons using samples obtained during routine and diagnostic examinations. Studies revealed possible exposure to GALV, but lack of integration or expression of the virus. Future studies on samples from other gibbon-holding institutions are planned in coordination with the gibbon SSP. This will aid in the determination, frequency, and time course of GALV seroconversion among captive animals, and further characterize any etiologic link between infection and disease.

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HUMAN SEROLOGICAL TESTING FOR *Baylisascaris procyonis* IN NON-HUMAN PRIMATES

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Abstract

The usefulness of a human enzyme-linked immunosorbent assay (ELISA) for *Baylisascaris procyonis* larval migrans was assessed in non-human primates (NHP). The test is a research assay performed at Purdue University. Six cooperating zoos submitted 259 NHP serum samples, spanning these major phylogenetic groups: I) Prosimians (n=54); II) New world monkeys (20); III) Old world monkeys (84); and IV) Hominoids (101). Sera were tested in duplicate using a microtiter-well ELISA using *B. procyonis* larval excretory-secretory proteins as antigen, and serum from an experimentally infected baboon as positive control (courtesy of Centers for Disease Control). The ELISA clearly identified seropositive animals in all zoos. Using putative cutoffs of optical density (OD_{405}) <0.150=negative; indeterminate; and >0.250=positive, 150 (57.9%) were clearly negative (mean OD 0.046) and 76 (29.3%) clearly positive (mean OD 0.657, range 0.253-1.773). Of these, 15 were high positive, with OD 1.095-1.773 (mean, 1.314); another 21 ranged from 0.530-0.998. Positive animals were seen from all zoos, and 74 (95%) were great apes or old world monkeys. The four highest ODs were in a siamang (*Symphalangus syndactylus*), lion-tailed macaque (*Macaca silenus*), Sumatran orangutan (*Pongo abelii*) and gorilla (*Gorilla gorilla gorilla*), all from different zoos. Prosimians had a mean OD of 0.039 and new world monkeys 0.021, indicating that human reagents either did not work for these groups or few infected animals were represented. These results indicate that the human ELISA for *B. procyonis* works well for at least higher phylogeny NHP, and that serologic evidence of infection is surprisingly common.

PRELIMINARY DATA ON THE MANAGEMENT OF CARDIAC DISEASE IN WESTERN LOWLAND GORILLAS (*Gorilla gorilla gorilla*) AT OMAHA'S HENRY DOORLY ZOO

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Abstract

Cardiac disease is a leading cause of morbidity and mortality in male gorillas. Omaha's Henry Doorly Zoo has 14 Western lowland gorillas (*Gorilla gorilla gorilla*) ages 1-36 yr. Twenty-eight echocardiograms have been performed on 10.2 gorillas. No animals exhibited clinical signs when echocardiograms were initiated. Following review of the first echocardiograms by the gorilla cardiac data base cardiologist, three males with varying cardiac abnormalities were started on graduating levels of a beta/alpha one adrenergic blocker and an ace inhibitor respectively. Maintenance doses achieved were: carvedilol phosphate (Coreg CR, GlaxoSmithKline, Research Triangle Park, NC, 27790, U.S.A.; 120 mg p.o., s.i.d.) and lisinopril (West-ward Pharmaceuticals Corp., Eatontown, NJ, 07724; 60 mg p.o., s.i.d.). On recheck echocardiograms 18 mo later, all three males showed noticeable improvement in cardiac function. Two more males were started on the same protocol. Subsequently, two of the original three males had clinical episodes. A 15-yr-old male developed a productive cough and was treated successfully over 11 days with reducing doses of furosemide (Lasix, sanofi-aventis U.S., 55 Corporate Drive, Bridgewater, NJ, 08807, U.S.A.; 80 mg to 20 mg, p.o., s.i.d.). A 13 yr old male became lethargic and lost a significant amount of weight. In addition to the beta blocker and ace inhibitor, this animal now receives digoxin (West-ward Pharmaceuticals Corp.; 0.375 mg p.o., s.i.d.) and aspirin (Major pharmaceuticals, 31778 Enterprise Drive, Livonia MI 48105, U.S.A; 325 mg p.o., s.i.d.). Currently, all gorillas are clinically normal. Echocardiograms will continue every 18 mo unless otherwise indicated.

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WHEN GOOD EGGS GO BAD: HATCHING ASSISTANCE AND NECROPSY

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Abstract

Avian eggs that are incubated naturally or artificially in captivity are often from valuable individuals or species that may be compromised by parental neglect or incorrect incubation parameters. These eggs may need to be salvaged through assisted hatching techniques. Additionally, eggs that fail to hatch should be opened for examination and embryos staged according to standard references to determine causes of mortality and potential future corrective actions.

Normal hatching process: To make sound decisions whether and when to provide hatching assistance, it is important to have a thorough understanding of the avian hatching process. At about 85% of the incubation period, the embryo has reached its maximum size and consumed any remaining fluids within the shell. Transillumination ("candling") reveals a sudden, apparent increase in air cell size with a newly irregular margin. Air cell volume is unchanged actually, but the inner and outer shell membranes have begun to separate around the air cell and the inner membrane, previously stretched tautly, is now draped loosely over the embryo. The embryo positions itself for hatching at this time. Although the head is initially between the legs, it moves along the right side of the body to position under the right wing with the egg tooth in position to pierce the air cell. The shadow of the beak tip pushing under the air cell may be seen on candling. With its spine aligned parallel to the long axis of the egg, the embryo's dorsal side corresponds roughly with the highest edge of the air cell and the ventral side with the lowest point. The chorioallantoic membrane (CAM) can no longer fully meet the respiratory needs of the embryo so slight hypoxia and hypercapnea result.[4,6] This metabolic state initiates a cascade of events that causes the hatching muscle (complexus muscle) along the dorsal neck to engorge with lymph and contract, causing the egg tooth to pierce the inner shell membrane. With this "internal pip", pulmonary respiration is initiated and the embryo's gas exchange improves so pipping contractions subside, and the embryo rests. At entrance to the air cell, the embryo also gains additional space to move within the shell, allowing it to use its legs as well as its neck for leverage during the hatching process. These body movements are essential in helping retract the remaining yolk sac into the body cavity before hatching is completed.

At this point, the embryo may be vocal and responsive to external stimuli, such as tapping on the shell and vocalizing by caretakers, by mimicking parental interactions. Respiration may be monitored by candling and should be even and rhythmic, in contrast to the irregular, jerky pipping contractions. Internal pip can be confirmed by hearing respirations through a stethoscope or by listening to the egg against one's clean ear. However, the embryo soon exhausts the limited oxygen supply within the air cell and pipping contractions resume, causing the egg tooth to pierce the shell ("external pip"). Once the outer shell membrane and shell are

pierced, the embryo can breathe outside air and it will rest for longer periods. Exposure to air and friction between the body and shell causes blood to recede from the CAM. Gradually, this membrane closes its vasculature, initially around the pip site and lastly around the umbilical seal. The confinement of the embryo within the egg prevents it from fully inflating the lungs and air sacs, so gas exchange again becomes inadequate and pipping contractions resume. The embryo first "breaks up" the pip site - often enlarging the opening, and after a brief rest, the embryo begins a counterclockwise rotation, breaking a new section of shell with each incremental shift of position. Rotation may be as little as half way around or more than a full circumference before the embryo pushes off the shell cap and rests again. Residual umbilical vessels connecting the umbilicus to the CAM dry with full exposure to air. It is preferred to allow the embryo to separate itself completely from the shell after resting as premature removal of the shell at chick emergence can tear the vessels and create a more accessible route for umbilical infection.

Assisted hatching techniques: By monitoring the hatching process in many healthy, self-hatching eggs, veterinarians and technicians will develop the ability to recognize when and to what extent intervention may be needed. Much emphasis is often placed on the time of the pip-to-hatch interval as a sole gauge in determining when to intervene. Although this is an important measure, it is somewhat arbitrary. For example, artificially incubated California condor eggs have an average pip-to-hatch interval of 72 hr but have successfully self-hatched in as little as 45 hr or as much as 96 hr after external pip. Lack of expected progress is usually the first indication that an embryo may require assistance. If the embryo is lethargic and unresponsive on multiple checks, shows labored respiration, or becomes frantically hyperactive, more immediate intervention will be needed to provide air to the embryo. If, after air cell draw down, the embryo's beak is not seen pushing under the air cell, it may be weak or malpositioned.[3] Another indication of possible malposition is an air cell that appears parallel to the short axis of the egg, rather than angled towards the sharp end of the egg. However, not all malpositioned embryos have abnormal air cells. In either case, radiographs would be indicated to determine the embryo's position within the egg. A length of surgical wire is used as a marker along the presumed ventral midline by lightly taping it to the shell at the blunt end where the air cell is located; this line should be traced on the shell surface in pencil, parallel to the long axis of the egg. Four views are imaged, starting with ventral-to-dorsal and rotating the egg 45˚ counterclockwise each time. These views will most clearly show the positioning of various structures.

If the embryo is correctly positioned for hatching and internally pips but fails to externally pip, minimal assistance may be sufficient. An air hole of 1-2mm may be made at the apex of the air cell using a 16-20 gauge hypodermic needle matched to the egg size, then carefully drilling through the shell; similarly, a hole could be created with a clean, small, pointed, abrasive bit and variable speed rotary tool. Fine forceps are then used to remove any shell membrane that occludes the opening. This assistance may be all that is required, but if the expected progress does not resume, further intervention is needed.

An egg that fails to internally pip should have an opening made in the shell over the air cell where the external pip was expected ("windowing"), using the technique described above. The

hole is then enlarged using forceps or hemostats, using the edge of the tool to control the size and direction of each break. The inner shell membrane overlying the CAM will be opaque, obscuring any active blood vessels, and should be moistened with sterile swabs and sterile water for injections or isotonic fluids to make the vessels visible. If CAM vessels are particularly heavy or refill rapidly after pressure is applied in the area where the artificial internal pip is to be made, potential hemorrhage can be reduced by repeated gentle massage with the moistened swab as the embryo's own movements would do. The inner shell membrane, CAM and amnion can then be opened over the embryo's beak tip and nares using blunt dissection technique to minimize bleeding. The amnion is still intact surrounding the embryo at this stage but as it is no longer fluid-filled and is so thin and avascular, it may already be pierced or may not be noticeable. Some bleeding is expected and may stop on its own or may require additional pressure around the edges of the opening in the CAM. To prevent membranes from becoming too dry, the opening in the shell, which is usually 1-2cm, depending on the size of the egg, must be partially covered. Tegaderm® (3M, St. Paul, MN 55144) or transparent tape that is not too sticky can be used to cover the window leaving a hole of 1-2mm to allow for air exchange. The egg should be positioned in the hatcher with the window uppermost to prevent residual fluids or blood from entering the mouth or nares. The egg should be checked frequently to ensure that beak and nares remain clear of membranes.

Despite high humidity in the hatcher and a covering over the window in the shell, membranes may still become dry, especially for species with a protracted hatching period. This concern is particularly important as shell membranes shrink markedly as they dry and can constrict the embryo. An over-the-counter artificial tears product, with light mineral oil as the primary ingredient, may be sparingly applied to keep membranes moist and pliable. Even embryos that start the rotation process on their own may be prevented from hatching by dry membranes alone, so only a little moistening may be required to complete the process.

Some embryos that are malpositioned are able to hatch unaided, but the majority of them require some level of assistance. For an egg that pips away from the air cell, it is important that, first, the pip has pierced both shell membranes and shell sufficiently to allow the embryo to begin breathing and, second, embryo must have sufficient space to inflate its lungs. With a normal internal pip, the embryo gains not only the air in the air cell, but roughly 15% more space. An embryo pipped away from the air cell cannot use this space until the pressure is relieved. The air cell is vented at its apex, as described above. The egg is then positioned in the hatcher on a slant with this vent at the bottom so that the weight of the embryo will gradually push the air out and allow the embryo to gain the needed room for respiration and movement that will aid in yolk sac retraction. Such embryos are often able to complete the hatching process without additional intervention.

A malpositioned embryo that fails to pip at all requires full intervention, beginning with a manual external then internal pip in a window as described above, placed directly over the beak which has been located radiographically. This opening is made in a similar manner to a window over the air cell, with the exception that no air space exists between membranes. The shell, membranes and CAM are parted in essentially a single operation. Some bleeding will occur but

will be less than might be expected as the embryo will have been rubbing against that particular part of the CAM vasculature.

Whether malpositioned or not, an embryo requiring a manual external and internal pip typically lacks the strength or ability to complete the hatching process unaided. These eggs are monitored frequently during the species-typical period needed for retraction of the yolk sac into the body, closure of the umbilical seal and complete shutdown of the CAM vasculature. For eggs that are easily candled, regression of CAM vessels can be readily monitored. With eggs that have more opaque shells, it may be necessary to gradually remove pieces of shell to assess progress, and determine whether the yolk sac remains exposed. An endoscope may used to better visualize active vessels or external yolk sac. When removing larger areas of shell, it is important to keep the air cell cap intact to prevent the embryo from pushing from the shell prematurely. Embryos that have protracted hatching periods and require invasive procedures should be treated with prophylactic antibiotics. If the embryo is large enough and a suitable injection site presents, this intervention may be administered parenterally before hatching has completed. Although antibiotics have also been administered by dripping the solution directly onto the CAM, no research has been performed to indicate whether this route results in effective absorption.

Once the majority of vessels have contracted and the yolk sac is retracted, it is safe to remove the embryo from the shell. In some cases, it is necessary to remove the embryo earlier if these processes are not occurring properly or if the embryo is becoming weak. In any case, this procedure is best handled sterilely to reduce infection. The embryo should be kept in the shell until the umbilical seal can be clearly seen. The shell should be removed over this area rather than sliding the embryo out, which may result in tearing of vessels. Membrane tissue and urates should gently be teased away from the umbilical area. The umbilical vessels may be ligated or cauterized if necessary, but are usually residual so can be crushed and severed 1cm from the seal. This site should be treated with a povidone iodine solution. If vessels are particularly moist or rough tissue surrounds the seal, 7% iodine tincture may be applied very sparingly to dry and effectively cauterize the tissue. Care must be taken to avoid the tincture entering the umbilical seal which leads to the abdominal cavity.

Chicks from eggs that have not lost sufficient weight during incubation will likely be edematous so are more likely to be malpositioned. Hatcher humidity is normally maintained at 70% relative humidity or higher in order to prevent membrane drying, but in these cases, it is contraindicated. The excess fluid must be gradually released through the lungs, so the hatcher should not exceed 50-60% RH. Edematous chicks tend to have partially open umbilical seals and these are difficult to close with sutures as the tissue is very friable. Occasionally, the yolk sac may be fully or partially unretracted. If the umbilical seal remains at least partially open, it may be possible to reduce a partially unretracted yolk sac. Sterile swabs lightly coated with oil-based ophthalmic ointment are used to stabilize the yolk sac intra-abdominally while the seal is sutured. If the seal has closed with all or part of the yolk sac unretracted, the residual usually must be amputated. It is important to note that a loop of intestine will be normally externalized before the yolk sac is withdrawn, so care must be taken not to ligate or sever this structure which will look similar to a residual blood vessel. While it is technically possible to surgically open the abdomen to insert the yolk sac, most chicks in this state are already so weakened that they are unlikely to survive

the procedure. As the yolk material is the primary nutrient and water source for the newly hatched chick, if the yolk sac is removed, feeding and supplemental fluids must be given almost immediately. Chicks requiring significant hatching assistance should be given a course of prophylactic antibiotics and may require additional supportive care.

Egg necropsy techniques: An egg necropsy starts with a thorough review of parental history and the individual history of the egg. Eggs that fail to hatch should be opened for examination and embryos staged according to the standard reference.[3] Although this work is based on the domestic chicken as a model, avian development is highly conserved and the descriptions are sufficiently detailed to make them appropriate for use with all avian species. Results may be characterized as follows:[1]

Clear on candling
I = infertile – white, centrally dense blastodisc and not donut-shaped as with fertile blastodisc
PD = positive development – white tissue partially covering yolk but no discrete embryo
FND = fertile/no development – white ring with clear center – blastodisc fails to reinitiate development after oviposition (rare)

Blood ring on candling
BWE = blastoderm without embryo – blood and membranes only
ED = early dead embryo (see below)

Obvious dead embryo
ED = early dead embryo – stage 1-19 (15% of incubation)
MD = middle dead – stage 20-39 (55% of incubation)
LD = late dead – stage 40-45 (30% of incubation)

Embryonic mortality of 7-13% is considered typical with roughly 1/3 of these in stages 1-19 and the remainder in stages 40-45, and nearly none during middle stages.[5] For eggs that are clear on candling, it is not possible to determine fertility or infertility without opening the egg and examining the contents. Late dead embryos may be necropsied in the same manner as for a neonate, including histopathology. Only late dead embryos that are sufficiently developed to have started the hatching process may be characterized as normally positioned or in one of the seven recognized malpositions according to the standard reference.[5] These findings may indicate problems with incubation parameters, parental nutrition, inbreeding or numerous other factors.[2,5] Results of breakout analysis, combined with parental and egg histories, may or may not provide definitive answers for a specific case but will surely contribute to analysis on a collection or population level.

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RETROSPECTIVE DISCUSSION OF NEONATAL MORTALITY (1990-2010) IN COMMON CHIMPANZEES (*Pan troglodytes*) WITH CONSIDERATION OF MATERNAL-FETAL INCOMPATIBILITY OF BLOOD GROUPS

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Abstract

Although great apes often serve as physiologic model species for humans, advances in human medicine can also be translated to their great ape counterparts. A pertinent example of this is blood group determination. Non-human primates have served both as the source of discovery, as in the Rh-factor discovered in Rhesus macaques (*Macaca mulatta*), and as recipient of human technology for blood group determination.[6] Blood groups refer to erythrocyte (RBC) membrane proteins that serve as antigens that can stimulate antibody production in an immunologically naïve recipient of a blood transfusion. Specifically in gestation, exposure to blood antigens between fetal and maternal circulation occurs via the hemochorial placenta and sensitization may result.[3,6]

"Maternal-fetal incompatibility" (MFI) is defined as any of several manifestations that occur when an offspring's blood is alloimmunized due to antibodies present in the dam's blood, and includes erythroblastosis fetalis, congenital anemia, icterus gravis neonatorum and hydrops fetalis. For MFI to occur, the fetus must possess a blood-antigen that is absent in the dam. Often times the first pregnancy is the initial exposure and does not result in any clinical manifestation of MFI. However, effects may be observed when the offspring ingests maternal lacteal antibodies or during subsequent gestations exposed to the pre-existing antibodies.

These antibodies cause the destruction of antigen presenting RBCs.[3] Clinical manifestations in affected offspring include marked increase in extramedullary hematopoesis (EMHP) of spleen and liver to combat the anemia secondary to erythrocyte destruction. Exposure of developing organs to extreme EMHP concentrations will result in reduced fetal albumin production and hypoproteinemic sequelae of hydrops, edema, ascites and bicavitary effusion. During gestation, fetal hyperbilirubinemia is not noted, even with marked RBC destruction, as the maternal liver often corrects for the icterus during gestation. Post-partum, however, the neonate no longer has the benefit of its dam's reserve hepatic capacity, so neonatal hyperbilirubinemia develops quickly.[1,3,8]

Sensitization from prior pregnancies is the most common situation associated with MFI in humans. However, antepartum hemorrhage, spontaneous abortions, ectopic pregnancies, abdominal trauma during pregnancy, and blood mistransfusions can similarly produce alloimmunization. Clinical procedures of amniocentesis, chorionic villous sampling or induced

abortions may also expose fetal to maternal circulations and cause alloimmunization. Twinning and chimeric gestations in non-human primates have been hypothesized as yet another predisposing factor for MFI.[3,8]

Since the discovery of Rh-factor, MFI in humans has been prevented by commercially prepared Rh_o(D) immunoglobulin (RhoGAM) that is administered to prevent alloimmunization. Prenatal parental testing for blood group is performed to establish risk of MFI. This preventive screening and administration of RhoGAM coupled with intravascular fetal transfusions has changed the emphasis from treatment to prevention of MFI, so human infants born with clinical signs for MFI are increasingly rare.[3]

In primate populations carefully managed for reproduction, neonatal loss due to preventable conditions is of great importance. MFI has been documented in a chimpanzee (*Pan troglodytes*)[8] and an orangutan (*Pongo sp*.)[1,5] secondary to non-uniform blood types. Infant death occurred due to erythroblastosis fetalis and marked hyperbilirubinemia due to severe hemolytic anemia. With completion of a recent study that evaluated great ape blood groups, investigation into potential MFI and reproductive loss is now possible. Focusing on chimpanzees of managed U.S. and European zoos and *in situ* managed populations (n=233), primary blood groups of A and O were identified, with A predominant in the population. Blood group O occurred in different frequencies in each population, especially by animal origin (zoo-born versus wild-origin).[2] Although blood group O in humans indicates a non-reactive state without antibodies present, it remains possible that blood group O in chimpanzees was simply non-reactive to human monoclonal antibody technology but could be reactive intra-specifically.

For this retrospective discussion, analysis of the Chimpanzee Species Survival Plan population's post-mortem data identified 45 deceased neonates up to 5 mo of age as candidates for MFI investigation. Available dam and sire blood groups, family tree assessment in context of reproductive history of the dam and sire, and available necropsy reports (n=35) were reviewed to identify possible MFI cases. Although conclusive determination of MFI was not made, parental and sibling blood group assessment in some family lines suggested potential risk. Clinical awareness of this diagnosis during pregnancy in great apes can prepare veterinarians to manage cases prophylactically or by treatment post-partum.

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NUTRITIONAL SUPPORT OF AN INFANT WHITE-CHEEKED GIBBON (*Nomascus leucogenus*) BY PERCUTANOUS ENDOSCOPIC GASTROSTOMY (PEG) TUBE

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Abstract

A 31-day-old white-cheeked gibbon (700gm) sustained a tracheal laceration by a bite from its dam. Although the wound was repaired, the infant was unable to nurse appropriately. The day following tracheal repair, the infant was anesthetized for endoscopic placement of a gastric tube (Bard Urologic Catheter, Covington, GA 30014 USA; 14 Fr with 18 Fr Pezzer head).

A bronchoscope (Olympus, Center Valley, PA 18034-8229 USA, 600mm, o.d. 3.8mm) and rubber catheter, for insufflation via syringe, were passed aborally into the stomach with the gibbon positioned in dorsal recumbency. An 18 ga hypodermic needle was introduced percutaneously where the endoscope light was visualized at the stomach's greater curvature. Monofilament fishing line was passed through the needle then withdrawn by endoscopic biopsy instrument and removal of the bronchoscope. The flared end of the tube was removed. The remaining tube was tied to the oral end of the monofilament and fitted into a disposable catheter tip through which the monofilament had been passed. Traction applied to the abdominal end of the monofilament drew the assembly into the stomach through the gastric and abdominal walls via a "stab" skin incision. The PEG tube was capped and secured with a stockingette vest.

Initial feeding was electrolyte solution (Pedialyte, Abbott Laboratories, Columbus, OH 43919 USA), followed by liquid human infant formula (Enfamil Lipil Instant Formula Milk-based Formula with Iron, Mead Johnson & Company, Evansville, IN 47721 USA). The infant's nutritional requirements were provided through the PEG tube until it was able to successfully nurse from a bottle 4 wk after repair.

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The authors wish to thank Minnesota Zoo animal care staff for their 24-hr care of this infant gibbon along with the University of Minnesota, College of Veterinary Medicine, Anesthesiology clinicians for anesthetizing the gibbon during the surgical tracheal repair and during the PEG tube placement.

HOSPICE IN ZOOLOGICAL MEDICINE

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Abstract

Forty years ago, in her landmark book "On Death and Dying", Dr. Elizabeth Kubler-Ross observed that "maybe at the end of our days, when we have worked and given, enjoyed ourselves and suffered, we are going back to the stage that we started out with and the circle of life is closed". As human life expectancy has lengthened, the need to openly and frankly manage end of life issues has increased. Over the last four decades, with increasingly sophisticated veterinary medicine, animal life expectancy, including that of zoological species, has similarly extended. By necessity, zoos have been coping with problems such as aggressive pain management and the need to incorporate end of life care into veterinary medicine. But these efforts have yet to include any formal acknowledgment that they are a simple form of hospice.

Hospice care for humans, and now for companion animals, includes much more than pain relief and geriatric medicine. It is instructive to review the concepts and basic practices of hospice and, the closely related field of palliative, care for their relatively recent application to companion animal care, and potential applications to zoological medicine. Formal acknowledgment and incorporation of these concepts and practices into zoological medicine could provide: 1) improved animal care, 2) reduced potential for bad publicity and conflict with the public and animal advocates, and 3) opportunities for personal growth of zoo visitors and staff.

β-AMYLOID AND AT8-IMMUNOREACTIVE PHOSPHORYLATED TAU DEPOSITS IN BRAINS OF NON-DOMESTIC FELIDS

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Abstract

β-amyloid deposition and tau phosphorylation are present in human cases of Alzheimer's disease, clinically producing a decline in cognitive function. These changes have previously been identified in domestic felids, associated with clinical cognitive decline in some animals.[1,2] This present study was performed to determine if similar β-amyloid and tau lesions can occur in non-domestic felid species.

Post-mortem brain specimens were collected from 15 non-domestic felids with specific focus on Asiatic lions (*Panthera leo persica*, n=7) that ranged in age from 3 d to 20 yr (mean 6 yr). Two animals - Pallas cat, *Felis manul*, 5 yr, and Asiatic lion, 7 yr - had neurologic clinical signs ante-mortem that were associated with infectious encephalitis. Mild degenerative changes (neuronal lipofuscinosis and vacuolar change with gliosis) were detected in two other animals - Persian leopard, *Panthera pardus saxicolor*, 20 yr, and cheetah, *Acinonyx jubatus*, 8 yr.

From these specimens, multiple brain sections (n=66) were assessed by application of monoclonal mouse anti-human β-amyloid (Clone 6F/3D, Dako, Glostrup, Denmark) and monoclonal mouse anti-human PHF-tau (Clone AT8, Innogenetics, Autogen Bioclear, Nottingham, UK) primary antibodies. Positive and negative controls were included in each batch processed.

β-amyloid deposition was detected in animals across the age range; however, as with previous studies in domestic cats, plaques were more diffuse than those seen typically in human Alzheimer's disease. Staining for tau phosphorylation was less definitive and only a few sections presented small positive foci. No association was seen between age and either β-amyloid or tau detection.

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DENTAL CONDITIONS OF CAPTIVE BLACK RHINOCEROUS (*Diceros bicornis*)

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Abstract

Dental disease is an important cause of morbidity in a variety of captive non-domestic species.[2,3] However, little is known about dental conditions of captive non-domestic browsing herbivores. As several unique disease syndromes have been associated with black rhinoceros (*Diceros bicornis*) in captivity,[1] careful husbandry and management of these animals is considered particularly important. Evidence of dental disease was consistently present in skull specimens from captive adult black rhinos (Citino, pers. comm.).

This report summarizes the dental conditions of eight black rhinos aged between 8 and over 30 yr. Only three of these individuals were exhibiting clinical signs of dental disease. All animals had sharp points on the buccal surface of the maxillary cheek teeth and lingual surface of the mandibular cheek teeth. Rhinos older than 8 yr (n=7) had some degree of dental calculus. Rhinos older than 11 yr (n=4) had multiple loose teeth and associated purulent gingivitis. Sharp points were filed smooth in all rhinos and calculus removed where indicated. Premolar extractions were performed in two rhinos with dental abscesses.

These results indicate that complete oral examinations should be performed on black rhinos regularly, regardless of the absence of clinical signs. Furthermore, black rhinos may benefit from preventive dental care. Dietary considerations, management, and genetics should be considered as potential reasons for the frequent occurrence of dental disease in captive black rhinos.

ACKNOWLEDGMENTS

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STEREOTYPIC BEHAVIORS IN ZOO ANIMALS

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Abstract

Stereotypic behaviors are one of the more common behavior problems seen in captive wild animals. For years it was believed that these behaviors were primarily a result of barren captive environments. However, it has been noted in many instances that simply improving the environment did not always completely stop the behavior. Much research followed that focused on the treatment of stereotypic behavior with environmental enrichment before we even had a very good understanding of what caused the behaviors. The biggest question remains today: why do some animals perform stereotypies and others in the very same environment do not? More recent research has given us some insight into the complex variety of factors associated with the development of stereotypic behaviors as well as the possible neurobiologic basis of the behaviors.

Stereotypies have been defined as invariant, repetitive behavior patterns without obvious goal or function.[13] They typically develop from normal motor patterns, such as those associated with foraging, grooming or eating. In the beginning, there may be some variation in the behaviors but with time, they become more fixed and inflexible. Stereotypic behaviors can vary dramatically between species and individuals within a species.

Interestingly, for a behavior that is defined as "without function or cause" much of the research has focused on looking for the cause of stereotypies. One hypothesis that has arisen suggests that stereotypies develop as a strategy to help animals cope with an adverse environment. Early studies focused on the self reinforcing aspect of the behaviors. It was hypothesized that the behaviors led to the release of endogenous opioids and individuals performing the stereotypies were self-narcotizing. Some studies have demonstrated that opioid antagonists do in fact disrupt the performance of stereotypies in some animals. Other studies have led to ambiguous results with some researchers concluding that "there is no evidence that performance of stereotypies results in increased opioid activity".[17] Overall there is no evidence that all stereotypies help animals to cope.[17, 22]

The one common unifying feature among animals exhibiting stereotypic behaviors is the presence of frustration: frustration that appears to arise due to the thwarting of very highly motivated behaviors.[3,17] The possibility that the environmental constraints placed on captive animals leaves them in a constant (or at least frequent) state of high motivation, has been considered by many as the more likely cause of stereotypies.[11,17,22] Motivated behaviors typically have an appetitive phase, the first phase of a behavioral series, that leads to a consummatory phase or "end act". Motivation is in some cases controlled by negative feedback: for example if consummation is successful (the leopard makes a kill) then the motivation to

perform the appetitive behavior is decreased (the leopard stops hunting). The term "appetitive" can be applied to many behaviors, such as foraging, exploring, searching for a mate or migrating. Motivational theories suggest that too often in captive animals, the appetitive phase of a behavior does not culminate in appropriate consummatory behavior, or the consummatory behavior does not follow a normal period of appetitive behavior. The failure of the negative feedback loops often leaves animals in a high state of motivation resulting in frustration related stress. Any number of unusual behaviors may follow.[3,11,17,22] The failure of some animals to stop the behaviors even after being placed in more appropriate environments that allow them to express more of their innate behaviors, has led some to suggest that stereotypies are the equivalent of a "mental scar" and do reflect some level of brain dysfunction.[11,17] Their continued presence is reflective of the frustration that occurred earlier in the individual's history.

Increasing evidence suggests that dysfunction within the basal ganglia of the brain is the underlying source of stereotypic behaviors.[5-8,12,21] Malfunction in the circuitry involving the basal ganglia and the prefrontal cortex has been shown to lead to perseveration of behavior, an inappropriate repetition of behavior and an inability to shift goals. Further, these studies suggest that stereotypies and impulsive/compulsive disorders are a result of dysfunction in two different systems within the brain and that they are two distinct classes of repetitive behaviors.[5,9,12,15] Impulsive/compulsive behaviors are repetitive, but unlike stereotypies, they are goal directed and they usually vary in the form of the motor patterns. The key difference between the two is in *what* is repeated. With stereotypies a motor pattern is repeated, such as walking a particular route in the cage and placing each foot in the same location every time. With impulsive/compulsive behaviors, an inappropriate goal is repeated, such as plucking feathers.[5] The distinction may prove critical in guiding future research and in our understanding of the prevention and treatment of these conditions.

Brain dysfunction may explain some of the mechanisms leading to repetitive behaviors but it appears that a variety of developmental and genetic factors may predispose individuals to develop the behaviors. It is notable that these factors are not necessarily the same as those environmental factors (such as barren environments) that elicit them. For example, a recent study in horses found that those animals with stereotypies had higher baseline levels of opioids than those without, suggesting some neurochemical difference in the animals that leads to the development of the behavior.[1]

Studies of the genetic basis of stereotypies are also offering some intriguing findings. There are distinct differences in the propensity to develop stereotypies within species. For example in one species of vole, it has been found that the offspring of mothers who exhibited stereotypies had a higher incidence of stereotypies than did the offspring of the non-stereotyping mothers.[18] In other rodent species, it has been shown that levels of stereotyping run in families.[18,19,22]

Developmental factors may also play an important role. Many studies have shown the lack of environmental complexity can be damaging, especially on young, developing animals. Animals raised in barren environments during the early weeks, months or years of their development have fewer neurons in the brain, decreased dendritic branching and spine density, reduced synaptic

connectivity and a higher incidence of stereotypies than animals raised in enriched envrionments.[2,12]

In addition to impoverished environments, other situations that cause severe stress, such as early or abrupt weaning, can also lead to abnormal neural development. When individuals are under extreme stress, they experience massive release of endogenous opioids. The presence of these opioids at an early age may sensitize the dopaminergic systems in the basal ganglia, possibly leading to the dysfunction that results in stereotypic behaviors.[11,12,22]

Research now suggests that early environmental complexity has a protective effect. This may explain why some wild caught animals exhibit fewer stereotypies in barren environments than animals born and raised in captivity. For example, a survey of adopted feral horses found that the feral horses had a much lower incidence of stereotypic behaviors than has previously been reported for other populations of horses.[4] Black rhinos, bank voles and African striped mice have all been shown to be less prone to stereotypies when wild born rather than captive born.[12,18,19] In captive settings, studies have shown that exposure to more complex environments may be effective when provided at a variety of different times during development and the timing may be more important than the duration of the exposure.[2,10,12,14,16,22] Studies in orange winged amazons have shown that stereotypies may be prevented and *reversed* by exposing them to more complex environments.[14]

A great deal of research has been conducted on the role of environmental enrichment in the treatment of existing stereotypies. These studies do suggest that environmental enrichment effectively decreases the performance of stereotypic behaviors by 50% in most cases. However, it is notable that most fail to completely eliminate the behaviors.[20] No matter what the original cause of a stereotypy may be, repetition strengthens the behavior by sensitizing the neuronal pathways involved. Treatment plans should be initiated immediately upon discovering an animal engaging in repetitive behaviors to be most effective. Animals that have been engaging in repetitive behaviors for years, or even a few months, are unlikely to completely stop the performance of the stereotypy.

Effective enrichment must be biologically relevant for the species being enriched. Caretakers should, to whatever extent possible, consider environmental changes that: increase opportunities for the animal to express species typical behaviors, appropriately increase sensory stimulation , and remove sources of stress for the animal.[20] Anything that increases an animal's control over the environment may be stress relieving and improve the animal's welfare. Where opportunities to modify the environment are limited or where they do not decrease the stereotypic behavior to a level that caretakers consider acceptable, pharmacologic therapy could be included in the treatment plan. Few controlled studies treating repetitive conditions in animals exist, so our knowledge is quite incomplete at this time. Tricyclic antidepressants (clomipramine in particular), the selective serotonin reuptake inhibitors, dopamine antagonists and the neuroleptics may all be effective at treating stereotypies.[15] As we learn more about the neurophysiologic basis for the different repetitive behaviors, our ability to use these medications in a safe and effective way should continue to improve. Part of any treatment plan for repetitive behaviors must include systematic documentation as to how often and under what circumstances the animal

performs the behavior. Only by documenting behaviors before and after different aspects of treatment have been initiated, can we truly learn what works and what doesn't.

While much has been added to the body of knowledge regarding stereotypic behaviors, much remains to be learned. The emphasis should continue to be on prevention by providing animals with complex environments and reducing stress during sensitive developmental periods. When possible, removing stereotyping animals from a breeding pool should even be considered. Research should continue to focus on understanding the multiple factors involved in the development of these behaviors. Ultimately, our goals should be to eliminate the cause of the behaviors, rather than continuing to treat the symptoms.

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THE INFLUENCE OF CAPTIVE MANAGEMENT ON REPRODUCTION IN PILEATED GIBBONS (*Hylobatus pileatus*)

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Abstract

The current worldwide studbook of pileated gibbons (*Hylobates pileatus*) reflects a skewed sex ratio towards males and poor reproduction. Thus, the captive population is threatened to become overaged and extinct without facilitating reproduction in the near future. Several factors are likely to contribute to the poor breeding success. Environmental factors such as management and housing condition, health related problems, social factors and/or chronic stress have been shown to have a major impact on primate reproduction. The present study evaluated all 12 current European facilities housing pileated gibbons in relation to husbandry, management and fecal glucocorticoid output to assess the potential impact of these factors for pileated gibbon breeding.

Enrichment and size of inside enclosure appeared to have a positive influence on reproduction while visitor access did not seem to have an influence. In addition, reproductively active pairs performed singing duets more frequently than non-reproducing pairs, and reproductively active females had regular visible menstruations in contrast to females that did not breed. Non-reproducing animals exhibited higher fecal stress hormone levels compared to reproducing animals. Remarkably, hand-reared animals also had higher fecal glucocorticoid levels.

Summarizing current results, it seems that careful selection of compatible pairs in combination with improvements in husbandry and management may reduce potential stress for the animals and thus may represent a basis for enhanced breeding. The small population size might require the import of unrelated and socially competent animals, especially females, to maintain a stable captive population in Europe and to prevent inbreeding in the future.

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TRAINING GIANT PANDAS (*Ailuropoda melanoleuca*) FOR VETERINARY PROCEDURES: NOT A BLACK AND WHITE WORLD

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Abstract

The medical management program of the giant pandas (*Ailuropoda melanoleuca*) at Smithsonian National Zoological Park, as with other species, is heavily based on preventive medicine; a key component of this program is the feasibility of performing a number of medical procedures under positive reinforcement training.

The first step in this program is the establishment of training priorities. Veterinarians discuss medical priorities and work with the keeper staff in order to develop a chronogram with training objectives. Then, the keepers will work on specific goals at times determined by their work schedule; once the animal follows specific cues the veterinary staff (veterinarians and veterinary technicians) is integrated into the routine training. It is not until one objective has been fully achieved that the staff starts to train the panda in another procedure.

Procedures that have been trained and maintained using positive reinforcement are:

- Annual vaccination (canine distemper virus and killed rabies vaccine),
- Indirect blood pressure measurements,
- Blood samples (complete blood counts, chemistry panel, serology, and serum banking),
- Thoracic radiographs
- Genital exam (vaginal exam/vaginal swabs and testicular measurements)
- Abdominal ultrasound for gestation monitoring in the female
- Intramuscular anesthesia injection
- Topical eye-drops

"FREE CONTACT" BEHAVIORAL CONDITIONING ALLOWING DIAGNOSIS AND TREATMENT OF DERMATITIS IN A 59-YEAR-OLD NILE HIPPOPOTAMUS (*Hippopotamus amphibious*)

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Abstract

A 59-yr-old female Nile hippopotamus (*Hippopotamus amphibious*) was diagnosed with and treated for severe *Streptococcal* dermatitis. Multiple diagnostics and treatments were performed with voluntary cooperation in a "free contact" setting, without use of sedation. The animal had a 15-yr history of positive reinforcement training for close contact with humans, tactile interactions, and open mouth for oral exam. In addition, the animal had a generally relaxed attitude, likely related to age and the absence of conspecifics. The hippo presented with large areas of skin depigmentation, erosions and ulcerations. Based on previous reports of *Streptococcal* dermatitis in hippos, treatment was initiated with amoxicillin (20 mg/kg p.o., b.i.d.; DAVA Pharmaceuticals, Inc., Fort Lee, New Jersey 07024, USA) and topical therapy.[1,2] Culture results confirmed beta-hemolytic *Streptococcus*, *Morganella morgannii*, and *Enterococcus sp.* Trimethoprim sulfa (30 mg/kg p.o., s.i.d.; Uniprim, Macleod Pharmaceuticals, Inc., Fort Collins, Colorado 80525, USA) was added to treat the amoxicillin-resistant *M. morgannii*. A veterinary dermatologist easily obtained two 8 mm punch skin biopsies without specific conditioning for the procedure. A blood sample was obtained from the ventral tail vein, though the behavior was not specifically trained. Serum chemistry results were consistent with renal disease. Subsequently, keepers implemented voluntary blood training. The food station was gradually moved onto a platform scale for routine body weight measurements. Behavioral conditioning allowed improved medical management in this geriatric Nile hippo, without the need for sedated procedures.

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FECAL GLUCOCORTICOIDS VARY WITH FACILITY AND AGE BUT NOT SOCIAL CONDITIONS IN CAPTIVE TIGERS (*Panthera tigris*)

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Abstract

While the question of whether the tiger (*Panthera tigris*) is a solitary or social organism in the wild remains unresolved, captive tigers are often co-housed with conspecifics. This study was undertaken to investigate whether age class or the number of conspecifics housed together in an enclosure had an effect on the stress of the tigers in the enclosure, as measured non-invasively by fecal glucocorticoid metabolite ("cortisol") levels. Radioimmunoassay of immune-reactive fecal cortisol was performed on feces collected from fifteen tigers at two different facilities. Each tiger was classified by facility, age class (designated as greater or younger than 8 yr of age), and social grouping (designated by number of co-housed conspecifics). There was no significant relationship between the number of tigers in an enclosure and the fecal glucocorticoid metabolite concentrations of the tigers within the enclosure. There was a significant difference in baseline fecal cortisol levels between the two facilities, as well as a significant difference between the two age classes, where higher levels occurred in the older tigers. The tigers at the facility that had higher fecal glucocorticoid metabolite levels are housed in close proximity to large interspecific carnivores, while the tigers at the facility with lower levels are only housed near other conspecifics, and have rotating access to a large enclosure. Under the specific husbandry conditions within this study, the number of tigers co-housed in an enclosure did not have a significant effect on the fecal glucocorticoid metabolite levels of the tigers within the enclosure.

APPLIED BEHAVIORAL ANALYSIS: THE SCIENCE BEHIND ALL THAT TRAINING

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Abstract

"Training" is now mainstream in many zoos and aquariums. Specifically, positive reinforcement training is being utilized to achieve a wide range of medical, husbandry, and public presentation behaviors in a multitude of zoological species.

Positive reinforcement training fits within a larger field of behavioral analysis and the techniques are applicable within and outside of the zoological field.[3,6,9,10,15] Behavioral analysis is the study of behavior change; how individuals learn behavior (i.e., operant behavior or conditioning).[2,5] Applied behavioral analysis is the utilization of this science "in the real world". The laws and rules that govern learning in individuals provide a robust method for examining behavior, productively evaluating and reducing problem behavior, and teaching (training) specific behavior.[2,6,9,15] They are conserved across species and thus applicable to all animals.

Behavior and why behavior develops or changes can be examined through a variety of sciences (e.g., neuroendocrine, genetic, physiology, etc.). As veterinarians, we are trained to consider medical causes for behavior or behavior change. For example, increased aggression (e.g., biting when touched) may be due to pain or a brain tumor. In the zoological field, we often consider natural history or evolutionary causes for behavior or behavior change. For example, biting may be from territorial defense during breeding season. In addition to these more familiar methods of behavior evaluation, behavioral analysis is critical for understanding how behavior develops and is maintained in an individual animal.[5] For example, biting developed because it was reinforced in the past; the animal has learned to do the behavior. These approaches are not mutually exclusive and integration is often integral to successful training and problem behavior intervention.

An excellent review of applied behavioral analysis for veterinarians exists.[5] The review examples are from parrots, but as noted above the principles are conserved across species. Certain highlights are presented below.

Behavior is a function of its consequence (The Law of Effect). A consequence is a stimulus, event, or condition that influences the strength of future behavior.[5] Reinforcers are consequences that maintain or increase a behavior; punishers are those that decrease behavior. The consequence is defined by what it does to behavior, not what it is.[5] Consequences can also be categorized based on input; positive if added to the environment and negative if removed/escaped/avoided. Positive and negative are mathematic concepts; there is no connotation of "good/bad." Thus, there are four consequence options (also called quadrants);

positive reinforcement ("reward"), negative reinforcement ("escape"), positive punishment ("discipline/correction"), and negative punishment ("penalty/fine") as displayed in Table 1. It is the learner who determines if something is reinforcement or punishment.[5] If you yell "stop it" when your dog barks and barking increases in frequency, intensity, duration, etc. then yelling is reinforcement to the dog, no matter what you want it to be!

Whether a consequence is reinforcement or punishment can only be fully evaluated by observing what actually happens to behavior in the future. Based on understanding an individual animal or species in general, it is possible to predict the likely impact of consequences on behavior. This predication is part of the basis for implementing purposeful training programs and developing problem behavior interventions. However, the actual impact on behavior must be evaluated to test if the prediction is correct.[5]

Behavior is never evaluated alone but is always considered within the context of the environment immediately surrounding the behavior and functionally related to it. Thus the smallest unit to evaluate behavior is the behavior (B) with the environmental brackets of the antecedent immediately before the behavior (A) and the consequence (C) immediately after the behavior (A-B-C).[5] The observable behavior of interest is defined first, using clear, concise language to describe the relevant behavior. Then the consequence and antecedent are identified and described. The ability to list and understand the functional relationship between a behavior and the environment around it is extremely important when trying to reduce problem behavior.[5] The functional analysis (A-B-C) becomes, in effect, a hypothesis to identify what, exactly, the problem behavior is and what consequences may be maintaining that behavior as well as the environmental cues that elicit the behavior. This functional relationship between A-B-C is also the fundamental relationship that is developed when specific behaviors are purposefully trained.

This process of receiving feedback from the environment and feedback modifying future behavior (i.e., learning) is completely natural and happens constantly "in the wild" as well as "in captivity".[2] While we may use it to purposefully train behavior, it is functioning at all times and not just in training sessions. Every interaction humans have with the animals in their care creates a "learning" opportunity. In addition, the animal's interactions with other animals and the overall environment will also be providing constant feedback as to the effectiveness of behavior.

There are predictable negative side effects to living in environments that provide higher amounts of negative reinforcement, positive punishment, and/or negative punishment than positive reinforcement.[5] These include apathy/reduced activity, aggression, escape/avoidance, and over-generalized aversion to environment.[2,5] There is increasing focus in all areas of captive animal management on purposeful training using positive reinforcement and also establishing environments that are filled with opportunities for animals to "naturally" obtain positive reinforcement (i.e., enrichment). Enriched environments that provide opportunities for choice, control, and positive reinforcement have been linked to improved behavioral and physical health in a variety of studies.[1,4,7,8,11-14,16]

Increased understanding of the scientific principles that underline how individuals learn behavior can allow veterinarians to more productively help prevent or manage behavior problems in captive animals and assist husbandry staff in training desired medical behaviors.

ACKNOWLEDGMENTS

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Table 1. Summary of the four consequence options.[a]

	Reinforcement (increase behavior)	Punishment (decrease behavior)
Positive (add)	**Positive Reinforcement (R+)** Addition is desired Commonly called: Reward	**Positive Punishment (P+)** Addition is aversive Commonly called: Discipline/correction
Negative (remove)	**Negative Reinforcement (R-)** Aversive is in antecedent Commonly called: Escape	**Negative Punishment (P-)** Removal is aversive Commonly called: Fine/penalty

[a]Modified from: Freidman, S.G, T.M. Edling, and C.D. Cheney. 2006. Concepts in behavior: Section I. In: Harrison, G.J. and T.L. Lightfoot (eds). Clinical Avian Medicine Volume I. Spix Publishing Inc., Palm Beach, Florida. Pp. 46-59.

DON'T JUST TREAT IT; STAND THERE: STRATEGIES FOR MANAGING PARASITES IN A CHANGING WORLD

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Abstract

Gastrointestinal parasites are a significant health concern for both domestic and non-domestic ruminants resulting in significant morbidity and mortality. In exotic artiodactylids, the primary species of concern in most collections are *Haemonchus* spp., which thrive in warm, humid climates. Other species can predominate in cool temperate regions, but these tend to be less pathogenic and generally are of less concern. Historically, parasite control programs in zoological institutions have relied heavily on empirical anthelmintic treatment programs, without the benefit of proper diagnostic surveillance. However, in recent years the gastrointestinal parasites of ruminants, both domestic and exotic, have developed high levels of resistance to many, and in some cases all available anthelmintic drugs. This development is causing grave concern for many zoological collections. In addition, the pharmacokinetics of anthelmintics is mostly unknown for exotic species, thus accurate dosing is a challenge. Consequently, it is becoming clear that old traditional approaches to parasite control are failing, and new strategies are required. Parasite control now and in the future must become more evidence-based, relying on constant surveillance of parasite loads, the use of fewer treatments and the regular testing of anthelmintics for resistance. In addition, the implementation of novel, non-chemical approaches in a program referred to as 'sustainable integrated parasite management' will need to be embraced.

MITES ON CAPTIVE INVERTEBRATES, TO TREAT OR NOT TO TREAT?

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Abstract

The captive environment of invertebrates in zoological collections is such that it may promote unusually heavy ectoparasitic mite burdens. The impact of mites on their hosts is poorly understood. *Androlaleaps shaeferi*, a mite found on Madagascar hissing roaches (*Gromphadorhina portentosa*) feeds on saliva and food debris and maybe other secretions.[4,5,6] Available data suggest this mite does not impact the health of the roaches, but studies correlating mite burden and roach health or performance have not been conducted. African giant millipedes (*Archistreptospirus gigas*) often harbor mites in the genus *Julolaelaps*.[3] The exact relationship between mites and millipedes has not been studied scientifically yet empirically these mites are labeled as commensals, or even beneficial to the host. This assumption has seldom been challenged. *Julolaelaps* mites are conspicuous, fast moving, and their presence is often objectionable to owners or caretakers. About half the giant millipedes collected from the wild were free of mites, indicating they are at least not essential to the host.[3] Mites were collected from African giant millipedes at the Bronx Zoo and identified as two different species of *Julolaelaps*. Using magnification, some mites were seen with their chelicerae seemingly inserted at the seam between tergites, raising questions as to their feeding habits. Histologically, millipede mites are sometimes found embedded deep beneath the cuticle, again suggesting mites may cause some morbidity. *Riccardoella* mites spend their whole life on slugs or snails, feed on hemolymph, and are transmitted by direct contact between snails, but they can also travel along slime trails to find a new host.[2] Snails are often raised in densities that optimize parasite transmission, exacerbate mite burdens, and make treatment difficult. Malayan giant black stag beetles (*Dorcus titanus*) at the Bronx zoo were partly white from dense aggregations of *Canestrinia* sp. mites. These mites are not known to feed on hemolymph, but often multiply to become a nuisance to the beetle.[1] Affected beetles buried themselves in dirt, maybe in an attempt to escape the mites. Mites that occur on beetles and other insects, on spiders, scorpions, and on centipedes are usually believed to be detrimental to the host, and treatment is seemingly recommended again based on anecdotal information. Phoretic mites are sometimes seen, mostly on wild-caught arthropods, but are unlikely to become a problem if the vivarium is regularly cleaned, and the substrate periodically changed. There is a need for a better understanding of the relationships between invertebrates and the mites they harbor, and on the impact of captivity upon that relationship. This requires that we be more proactive in getting mites identified and spend more time observing affected arthropods. Until such information is gathered, the presence of mites on invertebrates in zoological collections should be examined objectively by the clinician, and a decision to treat or not be made based on each individual case. The use of predatory mites, now commercially available, has shown promise and is a significant

improvement over alcohol swabs, flour "shake and bake" and other labor-intensive, potentially harmful treatment options. As the use of those predatory mites becomes more widespread, an efficacious protocol for mite treatment in invertebrates is likely to emerge.

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PREDATORY MITES AS A TOOL FOR ZOO VETERINARIANS

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Abstract

Captive invertebrates rarely display clinical signs or lesions prior to death. Their small size precludes most diagnostic procedures, and clinicians unfamiliar with invertebrate anatomy and physiology may not feel comfortable with examination, diagnosis, and treatment in these animals. Acariasis, however, is easily diagnosed as mites on giant species of millipedes, centipedes, roaches, beetles, spiders, scorpions, and snails, are usually conspicuous. Mites can easily be collected and examined using transparent tape, transferred to ethanol, and submitted to an acarologist for speciation. Treatment is often dismissed based on the empirical notion that mites on invertebrates are harmless to their host, yet a commensal relationship has only been reliably demonstrated for *Androlaelaps* (*Gromphodorholaelaps*) *shaeferi*, a mite found exclusively on Madagascar hissing roaches (*Gromphadorhina portentosa*).[3-5] Any such assumption regarding mites on all other invertebrate hosts is unsubstantiated and should not impact our decision to treat or not to treat. Toxicity for invertebrate hosts of acaricidal drugs used on pet and domestic mammals is a much more valid treatment concern. Manual removal is labor-intensive and other methods such as alcohol swabbing or flour 'shake-and-bake' are stressful and potentially harmful to the host, but a novel option is being explored for the treatment of acariasis in large invertebrates.

For over a decade now, a variety of mites have been used to address pests in greenhouses.[1] *Hypoaspis miles* is one such species of predatory mite that is commercially raised for the biocontrol of plant pests such as fungus gnats and thrips. These mites are sold under the scientific name *H. miles* but they may actually be *Stratiolaelaps scimitus*. They belong to a group of ubiquitous free-living predatory mites that are indiscriminate feeders, preying on other mites, small insects, springtails, mite and insect eggs and larvae, and even small nematodes. They are sold at a reasonable cost, admixed with chipped substrate by the liter, with each liter containing approximately 15,000 mites, in plastic jugs fitted with a dispensing lid. Upon release, predatory mites voraciously seek out prey, with each beige/whitish adult believed to consume 1 to 5 prey/eggs per day. When prey are exhausted, predatory mites will feed on each other, and eventually starve out. Years of use in commercial greenhouses attest to their efficacy, but actual scientific studies on these mites are scarce. Herpetoculturists first experimented with predatory mites to rid snakes of mite (*Ophionyssus natricis*) infestation in their collections. The general consensus, albeit anecdotal, is that treatment was successful. Similarly, anecdotal use of these mites to rid large arthropods and snails of *Riccardoella* spp. mite infestation met with success. Controlled trials have shown that *Hypoaspis aculeifer*, a close relative of *H. miles*, will actively feed on all stages of the red poultry mite (*Dermanyssus gallinae*) including eggs, and use of these and other predatory mites was investigated for poultry operations.[2]

Hypoaspis mites come with release instructions that should be followed closely. Invertebrates may be treated in their vivarium or moved to a simpler, sparingly furnished treatment tank for 3 to 6 wk. Common sense is used to assist predatory mites in their quest for prey and optimize the chances of success. The vivarium is kept warm and humid as mites may otherwise dry out. The set up should ideally not allow for invertebrates to bury themselves, as mites will not live beneath soil surface. Invertebrates are examined weekly to determine if predatory mites are proliferating and parasitic mites dwindling. Preliminary trials at the Bronx Zoo with *S. scimitus* (*H. miles*) mites to rid giant Madagascar cockroaches, African giant millipedes (*Archispirostreptus gigas*), and Malayan giant stag beetles (*Dorcus titanus*) of mites has met with conflicting results, probably due to logistical issues rather than inefficacity of the predatory mites. Further investigations are ongoing.

Other applications have yet to be explored. For example, predatory mites are known to also feed on small nematodes, suggesting they could be used in established exhibits of reptiles and amphibians as an adjunct to anthelmintic treatment of rhabditid and strongyloid parasites. These worms are hard to eliminate, as vivaria typically offer ideal conditions for their motile larvae to develop. Zoo veterinarians need be aware of predatory mites and their potential use so that through trials we can fully explore their potential in a zoological setting.

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REVIEW OF THE INTERNAL METAZOAN PARASITES IN DOMESTIC RATS AND MICE

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Abstract

The pathology records of domestic mice and rats with internal metazoan infections were reviewed. The submissions were primarily pet store animals purchased as pets or as a food source for other animals (raptors, reptiles, etc). From a total of 718 rats, 42 (5.8%) were found to harbor combinations of four different endoparasites. In the 172 mice, 99 (57.5%) carried metazoan parasites.

The parasites identified in rats included *Trichosomoides crassicauda* (bladder thread worm, n=8), *Rodentolepis* (formerly *Hymenolepis*) *nana* within the small intestines (n=4), Syphacia species within the colon and/or cecum (n=28), and cysticercoid cysts (*Strobilocercus fasciolaris*) embedded in the liver (n=4). The parasites in mice were *Rodentolepis* (formerly *Hymenolepis*) *nana* within the small intestines (n=27) and Syphacia species within the colon and/or cecum (n=77).

Three of these parasites (*T. crassicauda, Syphacia species, and R. nana*) have a direct life cycle. After the egg is ingested, *T. crassicauda* migrates to the urinary tract epithelium. Dead worms can serve as a nidus for calculus formation.[1] Pinworms commonly infecting laboratory rodents include the mice pinworms *Syphacia obvelata* and *Aspiculuris tetraptera*, and in rats *Syphacia muris*.[4] *Rodentolepis* (formerly *Hymenolepis*) *nana* is the primary cestode (dwarf tapeworm) found in the small intestine of rats and mice. This common tapeworm has a direct and indirect life cycle as well as being zoonotic.[2]

Rats serve as intermediate hosts for the cat tapeworm *Taenia taeniaeformis*. The cysticercoid cyst (*S. fasciolaris*) embeds in the liver. These lesions can be associated with sarcomas from the reactive tissue around the cyst.[3]

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ASCENDING RENAL FLAGELLATE PROTOZOAL INFECTION IN REPTILES

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Abstract

Six turtles (one eastern box turtle –*Terrapene carolina carolina*, one north American wood turtle –*Glyptemys insculpta*, one cogwheel turtle –*Heosemys spinosa*, one sulawesi forest turtle –*Leucocephalon yuwonoi*, one arakan forest turtle –*Heosemys depressa* and one toed box turtle –*Terrapene carolina triunguis*), four chameleons (two common –*Chamaeleo* spp. and two veiled chameleons – *Chamaeleo calyptratus*), one leopard tortoise (*Geochelone pardalis*), one frilled dragon (*Chlamydosaurus kingii*), one broad-headed skink (*Plestiodon laticeps*) and one green tree python (*Morelia viridis*) were included in this study based on a diagnosis of nephritis with intralesional flagellate protozoa. Of these, two turtles, one tortoise and one skink also showed similar gastrointestinal parasites associated with acute or chronic inflammation in all except one turtle. Also included is one gecko with severe cloacitis with intralesional flagellate protozoa, which were also observed in renal tubular lumen. One of the chameleons that presented with cutaneous discoloration also showed systemic flagellate protozoal infection and visceral coelomitis due to rupture of one kidney and release of exudate with flagellates and local spread into surrounding soft tissues including the skin. Ultrastructural studies on paraffin embeded renal tissue from this animal confirmed the protozoa as flagellates. These findings suggest renal flagellate protozoal infections, likely ascending from the lower alimentary tract, may be an important cause of renal disease in reptiles. This rarely documented condition has been referred to as hexamitiasis[1] in turtles and tortoises and to as monocercomoniasis[2] in snakes. However, it is unclear if all these infections are caused by *Hexamita* (synonym: *Spironucleus*)[1] or *Monocercomonas*, or if other flagellated protozoa are involved. The protozoal genera involved in the cases reported here in were not identified.

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INTRANASAL MIDAZOLAM FOR CONCIOUS SEDATION IN HISPANIOLAN AMAZON PARROTS (*Amazona ventralis*)

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Abstract

Conscious sedation of avian patients for routine clinical procedures (e.g., physical examinations, venipuncture, radiography, ultrasonography) is not commonly practiced, although several significant advantages may be afforded, including reduced handling-related stress and prevention of hyperthermia and tachypnea.[1-3] In a randomized, blinded, complete crossover study, midazolam (2mg/kg) (5mg/ml, Hospira Inc, Lake Forest, IL) or saline was administered intranasally to 9 healthy Hispaniolan Amazon parrots (*Amazona ventralis*) preceding 15 min of manual restraint. Birds receiving midazolam showed signs of mild to moderate sedation within 3 min of administration. Vocalization, flight and defense responses were significantly reduced during capture, and vocalization was significantly reduced during manual restraint. During manual restraint, mean cloacal temperature increased significantly slower and remained significantly lower ($p = 0.007$) in birds receiving midazolam (40.5 ± 0.2°C) compared to birds receiving saline (41.4 ± 0.6°C). For the first 6 min of manual restraint no significant mean temperature increase was recorded in birds receiving intranasal midazolam (0.27 ± 0.24°C, $p = 0.079$) in contrast to birds receiving saline (0.72 ± 0.37°C, $p < 0.001$). Mean respiratory rates in midazolam treated animals were significantly lower ($p = 0.008$) for up to 12 min of manual restraint. Intranasal flumazenil (0.05mg/kg) (0.1mg/ml, Abaxis Pharmaceutical Products, Schaumburg, IL) was used to antagonize the midazolam, and all birds recovered completely within 10 min. No untoward effects of intranasal midazolam and flumazenil administration were observed in this species. Intranasal midazolam should be considered as a simple, safe, effective, and readily reversible option for conscious sedation in Hispaniolan Amazon parrots.

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RODENTICIDE TOXICOSIS IN AVIARY BIRDS: INVERTEBRATES AS POSSIBLE VECTORS

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Abstract

A marbled teal (*Marmaronetta angustirostris*) and a great egret (*Ardea alba*) in an outdoor zoo aviary died without premonitory signs of illness. Gross necropsy revealed internal hemorrhage and liver samples from both birds tested positive for brodifacoum, a potent second generation rodenticide.

Bait stations were used within the aviary to control a heavy infestation of rodents, but the bait blocks were not directly accessible by birds. Stations consisted of a 12" x 14" plastic box with a single, round opening where rodents had to enter the box completely in order to access the bait within. The bait consisted of 0.005% brodifacoum in a solid, cereal-laced block. Bait blocks were checked every day by zookeepers and replaced when almost completely consumed. A zookeeper noted that she often saw slugs on the bait blocks. Slugs were likely attracted to the cereal component of the bait.

A stone curlew (*Burhinus oedicnemus*) and a black-crowned night heron (*Nycticorax nycticorax*) were found dead 1 mo and 6 mo respectively, prior to the teal and egret but were not tested for rodenticide levels at time of necropsy despite evidence of internal hemorrhage at necropsy.

Molluscs (slugs and snails) randomly caught throughout the aviary tested positive for brodifacoum. Subsequent feeding experiments illustrate that slugs and snails can bioaccumulate brodifacoum and bromadiolone, suggesting that they could serve as vectors for rodenticides in molluscivorous birds. It is important to note that sensitivity to rodenticides varies tremendously depending on bird species.[1]

ACKNOWLEDGMENTS

The authors would like to thank zookeeper Dina Pettit for her observations, and for collecting slugs and snails for the bait feeding experiment.

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Anaplasma phagocytophilum INFECTION IN CAPTIVE MANED WOLVES (*Chrysocyon brachyurus*) AT THE SMITHSONIAN CONSERVATION BIOLOGY INSTITUTE

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Abstract

Anaplasma phagocytophilum (previously known as *Ehrlichia equi*) is a tick-borne emerging pathogen that affects a variety of hosts, including humans.[1] In November 2009, clinical anaplasmosis was confirmed in two captive maned wolves (*Chrysocyon brachyurus*) at a facility in Front Royal, Virginia, USA. Affected wolves exhibited coughing, tachypnea and severe pulmonary congestion, splenomegaly, ataxia, anorexia, lethargy and dehydration. Mild jaundice and petechiation were seen in one of the two affected animals. Clinical pathology findings included leukocytosis, anemia and hyperfibrinogenemia. Diagnosis was confirmed by characteristic neutrophilic inclusions in peripheral blood smears, and PCR testing. A presumptive diagnosis was made on a third wolf, based on clinical signs, response to empirical therapy, and elevations in paired antibody titers. All animals recovered after treatment with doxycycline (300 mg p.o. b.i.d. for 21 days), but one animal (with more severe respiratory signs) concurrently received enrofloxacin (204 mg p.o. s.i.d. for 7 days). Serologic screening of eight adult maned wolves, including the affected animals, showed a 100% seroconversion, suggesting that maned wolves can be infected, not exhibit clinical signs, and apparently clear infections. *A. phagocytophilum* was originally detected a year previously at this facility, but prior to the current cases, no maned wolves had ever been affected. Prompt diagnosis and treatment when clinical signs appear are associated with a good prognosis for recovery from *A. phagocytophilum* infections**.**

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ORAL ALLERGY VACCINE FOR TREATMENT OF SEASONAL PRURITIS IN A SPECTACLED BEAR (*Tremarctos ornatus*)

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Abstract

Skin disease affects a large portion of the captive US spectacled bear population, with female bears often showing pruritis and progressive alopecia. A 21-yr-old female spectacled bear (*Tremarctos ornatus*) at the Houston Zoo had seven episodes of seasonal pruritis over a 10-yr period (1997-2006). The episodes occurred between May and October of each year and were characterized by constant scratching and by hair loss on the face, particularly around the eyes, and on the paws and flanks. Treatment with antihistamines, steroids, antibiotic and antifungal medications occasionally resulted in subjective temporary relief but never resolved the condition. In February 2007 intra-dermal skin testing for 55 local allergens was performed and revealed reactions to multiple pollens, trees and insects. A custom allergy vaccine was developed based on skin test results. The vaccine was mixed with honey and administered orally slowly via spoon to enhance absorption across oral mucous membranes. The vaccine was given initially twice weekly, frequency was then decreased to once weekly, and currently the bear is treated every other week. An objective scoring system to evaluate scratching was developed and indicated a notable decrease in scratching the first summer and continued marked improvement for the following two summers. The opportunity to administer the allergy vaccine orally, rather than parenterally, greatly enhanced our ability to treat this animal. Consultation with a veterinary dermatologist and intra-dermal skin testing for local allergens is recommended for bears with recurring pruritis and alopecia

CHOLECYSTOLITHIASIS IN A MANDRILL (*Mandrillus sphinx*)

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Abstract

Incidence of spontaneous cholecystolithiasis in non-human primates is low. As animal models for gallstone formation, potential correlations between diets high in polyunsaturated fats and low in cholesterol, leading to gallstone formation, have been seen in primates[1,3]. Additionally, review of cholecystolithiasis in both humans and non-human primates shows a predilection towards increased lithogenicity with increased age, pregnancy, and in females[2,4]. In this case, a 27-yr-old female mandrill (*Mandrillus sphinx*) had repeated occurrences of cholecystolithiasis. Different treatments were attempted over a 4-yr period, including medical management with ursodiol and surgery. Ursodiol resulted in complete resolution of the first incidence of cholecystolithiasis, while the second and subsequent bouts of cholecytolithiasis were only partially resolved. Evaluation of the animal's diet yielded no correlations to stone formation, and cholecystolithiasis has not been found in three other mandrills maintained on the same diet at the facility. The animal was treated successfully with a surgical cholecystectomy through a superior midline celiotomy, after medical management was no longer effective. The animal recovered without complication. Subsequent analysis of the cholecystoliths revealed a mixture of cholesterol, biliverdin and bilirubin. The animal died 4 mo later due to unrelated causes and evaluation of the cholecystectomy site showed normal healing and no surgical complications.

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EQUINE HERPES VIRUS 1 (EHV-1) OUTBREAK IN THOMSON´S GAZELLES (*Eudorcas thomsoni*) AND GUINEA PIGS (*Cavia porcellus*)

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Abstract

During an outbreak of equine herpes virus 1 (EHV-1) in a zoological institution, one Thomson´s gazelle (*Eudorcas thomsoni*) died acutely with neurologic signs, whereas a second individual showed neurologic signs progressing to stupor which allowed supportive therapy along with intramuscular florfenicol (Nuflor, Essex Tierarznei, München, Germany), flunixin-meglumine (Finadyne RP, Essex Tierarznei, München, Germany), and oral famciclovir (Famvir, Novartis, Barbera del Valles, Spain). During the following three days, three to six animals of a colony of guinea pigs which were housed in an adjacent room to the hoofstock area, were found dead each day. The second Thomson's gazelle and remaining guinea pigs were euthanatized due to high risk of infection and poor prognosis. Meningoencephalitis due to EHV-1 was diagnosed in all affected animals.

This is the first report of EHV-1 in caviidae but equine herpes viruses have been described to cause fatal infections in a range of non-equid species.[1,2,4,6,7] Thomson´s gazelles appear to be a particularly susceptible unnatural host.[3,5,8] Equid species were assumed the reservoir and the proximity of the susceptible species to equids is considered critical. The described Thomson´s gazelles were housed in a multispecies exhibit with other hoofstock, including zebras (*Equus quagga boehmi*).

After the outbreak, a serologic survey of all species kept in proximity with equid species was conducted. Unfortunately, there was disagreement in the results from different laboratories on the same samples but there was clear evidence for seropositivity in the equids. Vaccination protocols were introduced to prevent further outbreaks.

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CARBON DIOXIDE LASER KERATOPLASTY FOR TREATMENT OF CHRONIC BULLOUS KERATOPATHY IN A CALIFORNIA SEA LION (*Zalophus californianus*)

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Abstract

A 21-yr-old female California sea lion with bilateral cataracts exhibited OS blepharospasm, intermittently severe corneal opacity, and discomfort. The sea lion had a history of one episode of OS keratitis with punctate ulcerations 1 yr previously which had responded to medical therapy, as well as OS lens induced uveitis which was also controlled by medical therapy. Ophthalmic examination under general anesthesia revealed OS bullous keratopathy with secondary multifocal punctate superficial ulcerations. Medical therapy was attempted but response was marginal, controlling some discomfort but not resolving bullous keratopathy. Carbon dioxide (CO_2) laser keratoplasty was elected as possible definitive treatment. A CO_2 laser scanning head was used to diffusely contract the anterior corneal stroma to prevent bullae and subsequent ulcer formation. Post-operative corneal epithelial healing time (12 wk) was prolonged compared to thermokeratoplasty in domestic animals and one previously reported sea lion thermokeratoplasty procedure.[1,2] Significant post-operative behavioral complications including severe aggression and anorexia occurred, and were attributed to changes in management such as restricted water access and increased frequency of medication following the procedure. These behavioral complications limited topical and oral therapeutic options, which likely impacted healing time. Despite complications, successful resolution of bullous keratopathy, improved corneal clarity, and reduced pain were achieved. CO_2 laser keratoplasty can result in improved quality of life for sea lions with refractory corneal disease, but behavioral and training characteristics of individual sea lions can have significant impact on post-operative healing period.

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DIAGNOSIS AND MANAGEMENT OF INFLAMMATORY BOWEL DISEASE IN AN INDIAN RHINOCEROS (*Rhinoceros unicornis*)

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Abstract

A 20-yr-old, female Indian rhinoceros was diagnosed in early 2009 with inflammatory bowel disease based on weight loss, progressive diarrhea, bloodwork, and rectal biopsies. The rhinoceros had a previous history of a diffuse cutaneous vasculitis with epidermal necrosis in early 2008. By late 2008, a progressive diarrhea with weight loss was apparent. Bloodwork revealed a nonregenerative anemia, hypoalbuminemia, hyperglobulinemia, hyponatremia, and hypophosphatemia. Decreased serum folate and cobalamin levels were also observed. A protein losing enteropathy was suspected. A D-xylose study was unsuccessful. Rectal biopsies were collected using a small diameter PVC pipe passed into the rectum. A 3.0 mm, 3 m flexible endoscopic biopsy forceps was then repeatedly passed through the PVC pipe and manually guided to different sections of the rectum. The morphologic diagnosis was a severe, chronic, erosive, lymphoplasmacytic colitis.

Intramuscular dexamethasone was given to induce remission with a dramatic improvement in stool quality. Oral medications attempted included prednisolone and mesalamine with poor compliance. Rectal metronidazole was also attempted with no symptomatic relief. The best compliance and clinical remission was achieved with daily rectal prednisolone therapy via a suppository. The prednisolone was tapered over weeks to the lowest effective dose to reduce systemic effects. Repeat rectal biopsies documented an improvement in the degree of colitis. Over the 5 mo of immunosuppressive therapy, the diarrhea was controlled, but weight loss continued. Euthanasia was performed after 6 mo due to refractory weight loss. Necropsy confirmed the initial biopsy diagnosis with no indications of any opportunistic fungal or bacterial infections.

MEDICAL AND SURGICAL MANAGEMENT OF AN INDIAN RHINOCERIS (*Rhinoceros unicornis*) WITH SQUAMOUS CELL CARCINOMA OF THE HORN

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Abstract

A 39-yr-old female rhinoceros (*Rhinoceros unicornis*) had several vertical cracks and apical horn degeneration. The horn was removed with behavioral conditioning and gigli wire 1 cm above the germinal bed. Despite removal there was evidence of keratin damage below the removal site. This damaged area and a secondary area at the germinal bed, subsequently ruptured purulent material approximately 3 mo later. The entire horn was then surgically amputated at the germinal bed. Healthy horn re-growth occurred in approximately 85% of the horn. There was an area that was dysplastic that cultures and biopsies identified yeast and bacterial agents. Several subsequent partial horn amputations failed to restore complete healing. A follow-up biopsy diagnosed the non-healing area to have transformed into squamous cell carcinoma. Serial radiographs and bone biopsies indicated a mild periosteal reaction present in the underlying bone. Partial horn amputation was performed again, but recurrence of squamous cell carcinoma occurred in another location. To obtain a cure portable radiation technology, developed by Xoft, inc. makers of Axxent® Electronic Brachytherapy, eBx™, System was elected. XOFT performed Electronic Brachytherapy in two doses spaced 7 days apart. Treatment with eBx™ utilizes a miniaturized x-ray source to deliver high dose radiation to a target area at low energy, hence it can be performed without a lead shielded room. The area of focused radiation has healed with scar tissue, and keratinaceous horn re-growth has only occurred in parts of the horn where radiation was not performed. She appears to be free of squamous cell carcinoma 1 yr later. Squamous cell carcinoma has been previously reported in captive rhino.[1-3]

ACKNOWLEDGMENTS

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SEROPOSITIVE, CULTURE NEGATIVE TUBERCULOSIS IN AN ASIAN ELEPHANT (*Elephas maximus*)

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Abstract

In 2009, a 60-yr-old female Asian elephant was tested using the newest USDA guidelines of trunk washes in addition to blood collection for TB STAT pak testing. In 2010, TB STAT pak results indicate that this elephant was positive, but trunk wash culture was negative. Blood submitted to ChemBio Diagnostic Systems, Inc. for MAPIA was positive for Mycobacterium tuberculi/bovis. After discussion with USDA and many elephant authorities, it was determined that this elephant was at an increased risk for developing clinical disease. Anti-tuberculocidal therapy was then initiated for the next 9 mo for this elephant. Side effects of inappetance, front leg stiffness and lethargy were observed periodically throughout therapy. During the current 9-mo therapy, blood was collected weekly for serum banking. CBC's and chemistries were run monthly with no current abnormalities noted. Pharmacokinetic studies were performed regularly, and staff communication was intense with other outside sources for support. At the 3-mo mark, serum was submitted for MAPIA to monitor for seroconversion. In addition, the herd management of four other Asian elephants was intensified with regular trunk washes, CBC's and chemistries, and TB STAT pak testing twice yearly.

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CLINICAL APPLICATION OF A REAL-TIME QUANTITATIVE PCR ASSAY TO DETECT ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS INFECTION IN ASIAN ELEPHANTS (*Elephas maximus*)

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Abstract

Elephant endotheliotropic herpesvirus (EEHV) hemorrhagic disease accounts for approximately half of all Asian elephant deaths that occur in captivity.[2] Survival from EEHV-associated disease depends on rapid diagnosis and treatment of affected elephants. We have recently described a novel real-time quantitative PCR (qPCR) assay that detects EEHV1A and B, which are most commonly associated with mortality in captive Asian elephants in North America.[1] Using this assay we also determined that many healthy Asian elephants have been previously infected with EEHV1 and they frequently shed virus in trunk secretions.[1] Management of clinically ill animals would benefit with the availability of data describing viral loads and shedding in nasal secretions during the course of clinical disease. To address this issue we monitored the kinetics of EEHV1 viremia and shedding in the nasal secretions and urine of both subclinical and clinically ill captive-born Asian elephants during the course of infection and treatment. We found that peak viral loads were reached between 4-21 days following appearance of clinical symptoms. Detectable viremia persisted for up to 90 days for some animals. Virus was detectable in nasal secretions with slightly delayed kinetics relative to viremia in the blood and was still detectable at the end of the time period for collecting nasal secretions, which was several weeks following recovery. Low levels of viral DNA could also be found in some urine samples, which is a novel finding. This work is of significance for all veterinarians and elephant managers involved in the care of Asian elephants.

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EVIDENCE OF SPECIFIC BLOOD TYPES IN ASIAN ELEPHANTS (*Elephas maximus*) AND SIGNIFICANT INCIDENCE OF POSITIVE CROSSMATCH RESULTS

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Abstract

Knowledge of blood groups and blood types is important in making transfusion decisions. Blood group data have also been used by evolutionary biologists to measure genetic distances between populations. No studies have examined blood groups in elephants. Whole blood and serum from 41 Asian elephants (*Elephas maximus*) with no previous transfusion history were evaluated using a standard crossmatch tube agglutination test with a 15-min, 37^{o}C incubation. A positive crossmatch with at least two other elephants occurred in 73% of the elephants tested, suggesting that Asian elephants have natural occurring agglutinating antibody to blood types they do not themselves demonstrate.

The same 41 elephants were also evaluated for warm agglutinating antibody to erythrocyte antigens by tube agglutination. One elephant demonstrated evidence of an antibody against a high incidence antigen present on 80% of erythrocytes. Seven other antibodies were identified that showed reactivity to 20% of the erythrocytes tested

To demonstrate that antigenicity was erythrocyte-based, adsorption studies were performed. Crossmatch reactivity was successfully removed from serum by adsorbing the serum to red blood cells carrying the corresponding antigen. The elephant described above required two different and separate adsorptions to remove all reactivity, suggesting either that elephants blood types may involve more than one blood group or that the red blood cells of some elephants bear multiple antigens.

Although the in vivo reactivity of these erythrocyte antigens is unknown, these findings suggest that elephants need to be crossmatched prior to whole blood transfusion. Additional characterization of these antigens and antibodies are underway.

ANALYSES OF TWO BIOMARKERS OF COLLAGEN II TURNOVER IN SERA OF CAPTIVE ASIAN ELEPHANTS (*Elephas maximus*)

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Abstract

Presently, there is no effective means of assessing osteoarthritis in elephants before animals show clinical evidence of lameness.[4] Typically, osteoarthritis is advanced before joint changes are seen on radiographs.[3] Leg radiographs from above the carpus and tarsus are typically non-diagnostic due to size and conformation. Techniques are needed to objectively detect and assess osteoarthritis in elephants before the onset of lameness and pain. The purpose of this study was to investigate the utility of C2C, a collagen II degradation product, and CP II, a collagen II formation product, as biomarkers of osteoarthritis[1,2] in Asian elephants using commercially available assays. We compared serum C2C and CPII concentrations in a cross sectional analyses of non-arthritic (n= 33) and arthritic (n=7) Asian elephants and endeavored to elucidate trends in serum marker concentrations during the pre-clinical period and during treatment for the condition. Sera were obtained from Asian elephants at participating U.S. zoos and stored at -80 ^{o} C until analyses were carried out. Samples were analyzed using commercially available assays (C2C ELISA; CP II ELISA, IBEX Technologies Inc., QC H4P 1P7, Canada) according to manufacturer instructions. Median values of both C2C and CP II were statistically greater in the non-arthritic group than in the arthritic group. These differences were statistically significant; $p = 0.0002$ (C2C) and $p = 0.039$ (CP II) respectively. The study presents a novel approach to the diagnosis of osteoarthritis in Asian elephants. Further studies involving these and other biomarkers are needed to elucidate its usefulness.

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NOT ALL RADIOLUCENCY IS OSTEOMYELITIS: A CASE REPORT OF AN AFRICAN ELEPHANT (*Loxodonta africana*) WITH A P3 LESION

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Abstract

A 37-yr-old, female, long-term captive African elephant developed a persistent nail lesion of the second digit on the left fore foot. The initial lesion was a soft spot along the coronary band, with subsequent undermining of the face of the nail. The severity of the lesion waxed and waned for 2 yr. It was treated primarily with aggressive debridement and nail trimming, and applications of various topical products. Late in the second year, several attempts at maintaining a bandage were made. Serial radiographs of the digit were taken to monitor for signs of bony involvement. After 2 yr, radiolucent lesions were seen in P3 of that digit and the decision was made to remove P3. P3 was removed via the defect in the face of the nail and antibiotic-impregnated polymethylmethacrylate beads placed in the surgery site. No attempt was made at primary closure and the surgical site closed slowly over the course of several weeks. Histopathology of the removed P3 showed necrosis and fibrosis, but no osteomyelitis. At the time of surgery, radiology showed no radiolucencies in P2 of that affected digit, however within several months after surgery, radiolucencies were observed in P2. It was decided not to attempt any further surgeries. At necropsy, 6 yr after surgery, histology of P2 showed evidence of previous bony remodeling, but no inflammation. Based on this experience, clinicians should be cautious in interpreting radiolucent lesions of the elephant phalanges as indicative of infection.

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The authors would like to thank Dr. Phil Boschler and the elephant staff at the Knoxville Zoo for their efforts with this case.

SUSPECTED SEMINAL VESICULITIS IN AN ASIAN ELEPHANT (*Elephas maximus*)

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Abstract

A 32-yr-old male Asian elephant (*Elephas maximus*) underwent routine ultrasonographic assessment and transrectal stimulation for semen collection as part of the artificial insemination program.[3,4,8] The procedure consisted of a pre-artificial insemination semen collection followed by the true semen collection on a following day. The second days' sample contained inflammatory cells, intracellular bacteria, and phagocytized sperm. Culture revealed *Acinetobacter lwoffii, Staphylococcus intermedius,* and *Kocuria roseus*. Empirical antibiotic therapy with trimethoprim sulfa (24mg/kg orally once daily) was initiated and then tailored based on the sensitivity panel to enrofloxacin (5mg/kg orally once daily). Enrofloxacin has been evaluated in elephants and the seminal fluid concentration has been determined in horses.[1,2,7] Diagnostic semen collections were performed during treatment and 2 wk post treatment to determine the success of therapy. Post-treatment collections revealed resolution of the inflammation. The origin of the infection was suspected to be in the seminal vesicles.

Typical isolates in seminal vesiculitis include *Arcanobacterium* sp., *Acinetobacter* sp., *Streptococcus* sp., and *Pasteurella* sp. Management in those domestic species typically varies from benign neglect, systemic antibiotics, locally infused antibiotics or surgical seminal vesiculectomy in more extreme cases.[5,6] The latter is less practical as treatment of seminal vesiculitis in an elephant.

Reproductive infections represent a challenging and realistic problem in elephants. The increasing usage of semen collection and artificial insemination has revolutionized elephant reproduction and has allowed further assessments of their reproductive tracts.

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DILATED URETERS, RENAL DYSPLASIA AND CHRONIC RENAL FAILURE IN AN AFRICAN ELEPHANT (*Loxodanta africana*)

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Abstract

An ultrasonographic reproductive health examination in 2007 of a 26-yr-old female African elephant (*Loxodanta africana*) showed bilateral ureteral wall thickening and dilatation. The bladder and both ureters were ultrasonographically normal in appearance near the trigone, however cranial-most aspects of the ureters were dilated and thickened for a length of 30-50 cm. The right ureter was less dilated (2.5 cm diameter) than the left (10 cm diameter). The left kidney had a slightly hyperechoic appearance. The same month, continually elevated blood creatinine (3.0 mg/dl) and urine protein:creatinine (UPC) ratio (4) were observed. Chronic renal failure was diagnosed based on these abnormalities and persistent ureteral dilation on subsequent ultrasound examinations.

The elephant was monitored for 2.5 yr with weekly CBCs, serum chemistries, and urinalyses. Initially, specific gravity remained between 1.010 and 1.022, but dropped to 1.002 – 1.006 by mid-2009. In the fall of 2009, UPC and creatinine began to decline. Hypophosphatemia (2.0-2.6 mg/dl) and hypercalcemia (20-22.5 mg/dl) including an elevated ionized calcium (2.2 mmol/L), developed. Ultrasound showed increasing dilatation of the right ureter (8 cm), hydronephrosis of the left kidney, and prominent sacculation of the left ureter. Lethargy, ventral edema and oral mucosal ulceration acutely developed, presumably secondary to renal failure. Due to rapid clinical decline and grave prognosis, humane euthanasia was elected. Bilateral ureteral dilatation, aplasia of the right kidney (right: 0.57 kg; 19.5 × 11.5 × 3 cm; left: 8.57 kg; 37.5 × 24 × 11.5 cm), and chronic renal failure of the left kidney were identified at necropsy.

EPIDEMIOLOGY OF FELINE HERPES VIRUS (FHV) INFECTION IN A POPULATION OF CAPTIVE SOUTH AFRICAN CHEETAHS (*Acinonyx jubatus*)

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Abstract

Feline herpes virus (FHV) is a viral infection endemic in captive cheetahs (*Acinonyx jubatus*). While some cheetahs acquire a self-limiting rhinitis and chronic epiphora, others appear to be especially vulnerable to disease and can experience severe and persistent clinical signs or conditions, including keratitis, corneal ulcers, conjunctivitis, uveitis, blindness, cutaneous ulcers, or pneumonia.[1-3] Acute infection has necessitated the euthanasia of several animals,[3] which further impedes breeding efforts and impacts captive population sustainability. To better understand the epidemiology of FHV in cheetahs, medical records from cheetahs at six different institutions were examined over a several year period to identify confirmed cases and those with clinical signs consistent with FHV. Disease incidence and population level infection characteristics were summarized. Cox proportional hazards regression models were fit to the data to identify demographic and management factors associated with FHV. Forty percent (61/154) of cheetahs in the population acquired infection during the study period and 21% (32/154) had severe clinical signs. The majority of FHV cases (57%; 35/61) occurred when cubs were less than 4 mo of age. Among cheetahs with positive dams, hand-rearing was protective against FHV infection. Among cheetahs without positive dams, having a FHV-positive littermate was identified as an important risk factor for disease, suggesting that littermate status may serve as an indicator for identifying asymptomatic carrier dams. These results highlight the importance of FHV as a limiting factor in the health of captive cheetah populations and provide insight as to how to improve disease management efforts in cheetahs.

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RECENT CASES OF SKELETAL FLUOROSIS IN CAPTIVE COLONIES OF FRUIT BATS (*Artibeus jamaicensis, Pteropus hypomelanus, P. vampyrus, P. rodricensis, P. giganteus, P. poliocephalus*) AT MULTIPLE INSTITUTIONS

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Abstract

A geriatric colony of Jamaican fruit bats (*Artibeus jamaicensis*) at Zoo Miami was found to have an increasing occurrence of proliferative boney lesions on long bones of the wings, legs, and mandibles, which frequently were associated with decreased ability to fly and weight loss and led to euthanasia in numerous cases. Gross and histologic examination of the bone lesions revealed changes consistent with previously reported and unpublished cases of skeletal fluorosis in bats (Trupkiewicz, J.G. and D.M. Ialeggio, pers. comm.).[4] Laboratory measurements of fluoride content of the bones of grossly affected and unaffected bats revealed high levels consistent with fluoride toxicosis (1649-2338 ppm, wet-weight).[4] These values were compared with bone fluoride measured in another species of fruit bat (Seba's short-tailed fruit bat, *Carollia perspicillata*) that had been at Zoo Miami for less than 6 mo whose values appeared to fall within a more normal expected range (392 ppm, wet-weight). Contact with the Lubee Bat Conservancy and the Oakland Zoo revealed similar cases of elevated skeletal fluoride levels and osteoproliferative lesions in other species of fruit bats (*Pteropus vampyrus, P. hypomelanus, P. rodricensis, P. poliocephalus, P. giganteus,* as well as *A. jamaicensis*). The *Pteropus* spp. had hyperostotic nodules predominantly in thumbs and digits and around the gumlines, suggesting a difference in predilection for proliferative lesion sites in various bat species, or different stages of the disease process. Dietary, water, and some substrate (rockwork, soil, caging) sources for fluoride were investigated separately at each institution, using different laboratories and testing methods. No conclusive source for the elevated fluoride levels was discovered; however it was determined that a specific powdered supplement, and calcium diphosphate added to some diets, may have been the greatest contributors to the overall fluoride load in these bats. A survey was circulated by the Lubee Bat Conservancy to all zoos holding bats in North America, and a few respondents confirmed that they also had seen clinical cases which were consistent with fluorosis. Fluoride requirements and toxic levels have not been established for most species other than humans and domestic cattle, but excessive levels can result in bone and joint pain, tooth and skeletal lesions, polydypsia, and decreased feed intake with condition loss.[1,2,3,4,5,6] Bats may be very susceptible to unrecognized additive quantities of fluoride in multiple dietary and environmental sources. The producer of the powdered supplement has worked closely with a nutritionist and the Lubee Bat Conservancy to restrict fluoride levels in their diet since the discovery of these cases. A newly formulated supplement powder now contains fluoride levels of 4-5ppm. Other possible sources of fluoride at each institution, including fluoridated water and

various substrates, were evaluated and attempts made to eliminate or reduce the bats' cumulative exposures.

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EQUINE HERPESVIRUS: IMPLICATIONS FOR PREVENTIVE MEDICINE IN COMMON ZEBRAS (*Equus burchellii*), HARTMANN'S MOUNTAIN ZEBRAS (*Equus zebra hartmannae*), AND THOMSON'S GAZELLES (*Gazella thomsoni*)

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Abstract

Equine herpesvirus 9 (EHV-9), also known as gazelle herpesvirus 1 (GHV-1), has been identified as the etiologic agent involved in an outbreak of fulminant neurologic disease in Thomson's gazelles (*Gazella thomsoni*) as well as encephalitic disease in a polar bear (*Ursus maritimus*) and a reticulated giraffe (*Giraffa camelopardalis reticulate*).[1-4] Additionally, the virus has been implicated as the cause of respiratory disease in Grevy's zebras (*Equus grevysi*) and abortion in a Persian onager (*Equus hemionus onager*),[3] and has caused clinical signs in a variety of experimentally infected domesticated and exotic species. Zebras are thought to be the natural hosts of EHV-9, thus provoking concern regarding potential interspecies transmission when zebras are kept in zoo exhibits with Thomson's gazelles. With cross-reactivity between equine herpesvirus 1 (EHV-1), equine herpesvirus 4 (EHV-4) and EHV-9, diagnostic screening is possible with available ELISA methodology. Banked serum samples from fourteen Thomson's gazelles, six Common zebras, and four Hartmann's mountain zebras were submitted for EHV-1 antibody titers. None of the sampled animals had previously been vaccinated against EHV-1 or EHV-4. All zebras had positive EHV-1 titers while all Thomson's gazelles had negative titers. Further analysis using viral isolation or PCR would be necessary to determine if virus is present in animals with positive titers.

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RETROSPECTIVE REVIEW OF ROUTINE MYCOBACTERIAL SCREENING IN A CAPTIVE COLLECTION OF ATLANTIC BOTTLENOSE DOLPHINS (*Tursiops truncatus*)

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Abstract

Non-tuberculous mycobacteriosis has been reported in cetaceans.[1-5] Normal results of acid-fast cytology and mycobacterial cultures from cetaceans are not well established and some have theorized that the aquatic environment may increase the risk of false positive test results. In 2004, an adult male Atlantic bottlenose dolphin (*Tursiops truncatus*) at the National Aquarium was evaluated for respiratory disease. Non-tuberculous mycobacteriosis was initially suspected when beaded, gram-positive rods were identified on diagnostic samples from respiratory secretions and gastric fluid. The bacteria appeared morphologically similar to non-tuberculous mycobacteria routinely identified in fish mycobacteriosis cases. Acid-fast stained cytology, culture/PCR testing, and histopathology subsequently supported a diagnosis of pulmonary *Mycobacterium abscessus* infection.[3]

Screening of fluid and tissue samples from the remaining population was instituted. Samples were collected during routine quarterly health exams or as part of diagnostic evaluations. All animals were managed in an indoor, artificial saltwater system with ozone disinfection.

Between October 1, 2004 and December 31, 2009, 913 acid-fast cytology and 74 mycobacterial culture samples were evaluated from 13 animals. Acid fast stained cytology samples were 99% negative (904/913) and 1% positive (9/913). Culture samples were 95.9% negative (71/74) and 4.1% positive (3/74). *M. abscessus*, *M. aurum/neoaurum*, and *M. neoarum/lacticola* were identified on positive cultures. Cytology and culture results were overwhelmingly negative for acid-fast positive organisms and mycobacteria. Positive results were sporadically identified, not repeatable, and primarily consistent with environmental contamination. Repeatable, positive results on either test are considered abnormal and additional follow-up would be warranted.

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VETERINARY ASPECTS OF ESTABLISHING A CAPTIVE COLONY OF THE VIRGINIA BIG-EARED BAT (*Corynorhinus townsendii virginianus*)

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Abstract

In response to the threat of the advancing "white nose syndrome" epizootic into the range of the Virginia big-eared bat (*Corynorhinus townsendii virginianus*), the feasibility of establishing a captive, insurance population was explored. Forty adult bats were captured from a cave on 9 November 2009, and placed in an ex situ, indoor, free-flight facility at the Smithsonian Conservation Biology Institute, in Front Royal, VA USA. Ectoparasites were common, and were eliminated using topical fipronil. Bats were successfully transitioned to feeding on gut-loaded mealworms, initially by hand feeding until adequate self-feeding occurred. The transition occurred slowly over weeks to months, with significant individual animal variation. Supportive care and treatment with fluids was necessary until bats were eating and drnking voluntarily.

Significant morbidity was initially associated with ventral thoracic, cervical and facial dermatitis, likely secondary to excess moisture or adherence of organic material to the fur. Although most cases resolved with treatment, severe cases in debilitated animals presumptively led to septicemia, and death. The onset of a high incidence of carpal abrasions and thumb necrosis correlated with the transition to self-feeding, which in severe cases led to digit amputations and, in some animals, death with presumptive septicemia. Early treatment with systemic and topical agents, including hydroactive gels that prevent excess scar tissue formation, were beneficial to the re-epithelialization of digit abrasions and prevented constrictive band necrosis. Bats could recover and adapt well after thumb amputations. Increased time spent weight bearing or ambulating on carpi and thumbs likely predisposed bats to the development of lesions. Bacteria commonly isolated from sick or dead animals included *Serratia marcescens*, *Staphylococcus sp.* and *E. coli*, suggesting that opportunistic pathogens had invaded open lesions. Animals under chronic systemic antibiotic therapy occasionally developed secondary yeast infections. Cestodiasis, gastric cryptosporidiosis, connective tissue nematodiasis and skin mites were additional findings in some cases. In conclusion, significant challenges were encountered in transitioning the insectivorous Virginia big-eared bat from nature to an ex situ environment.

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Erysipelothrix IN A RED KANGAROO (*Macropus rufus*)

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Abstract

Erysipelothrix infections have been seen in captive macropods held in the UK, Australia and Europe. Cases have occurred sporadically and after periods of heavy rainfall.[1] Typical clinical signs are similar to swine: urticarial or necrotic skin lesions on the limbs or trunk, gingivitis, oral mucosal lesions and acute death.[2] This disease is diagnosed typically at necropsy by culture collected from major organs. If initiated early, therapy with penicillins, potentiated sulfonamides and tetracyclines may be curative.[1] In 2009, a case of *Erysipelothrix* occurred in Missouri after a period of heavy rainfall. At morning check, a 4-yr-old female red kangaroo (*Macropus rufus*) presented with lethargy and was isolating from the group. By early afternoon, she was found unresponsive and seizuring several hours later. Based on physical exam findings of ascites on radiographs/ultrasound and edema of the extremities, a presumptive diagnosis of disseminated intravascular coagulopathy (DIC) was made. A toxemic etiology was suspected, due to concurrent evening events being held on zoo grounds. During treatment, this animal went into cardiac arrest and was ultimately humanely euthanatized. Blood was collected from the heart following euthanasia. Necropsy revealed a dark purple to black heart, petechiation of the kidneys, mucous membranes, mesentery and intestines, and moderately congested lungs. Histopathology confirmed DIC with acute septic gram-negative rods present in the intestinal villi. Blood was submitted for aerobic culture and staining. Blood smear stains were negative, but *Erysipelothrix* spp. was successfully isolated from whole blood. To our knowledge, this is the first of two occurrences to be reported in the United States of this disease entity.

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A RETROSPECTIVE REVIEW OF MORBIDITY AND MORTALITY IN PANGOLINS CONFISCATED FROM THE ILLEGAL WILDLIFE TRADE IN VIETNAM

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Abstract

Pangolins (*Manis javanica* and *M. pentadactyla*) are some of the most commonly traded mammals in the illegal wildlife trade. Little is known about their physiology and pathology. Morbidity and mortality in captivity has historically been high. In 2006, a rescue centre was established in Cuc Phuong National Park, with the aim of developing veterinary and husbandry guidelines for the rehabilitation of confiscated pangolins.

Between 2006 and 2010, 36 pangolins (*M. javanica* (n=35) and *M. pentadactyla* (n=1)) were received, and 4 pangolins were born in captivity. Detailed records describing presenting signs, veterinary treatment and clinical response were kept. Most pangolins were in poor condition on arrival. Documented clinical signs included snare trap (n=2) and dog bite wounds (n=1), pyoderma (n=25), and corneal ulceration (n=1). A single confiscated, pre-weaned juvenile (700gm) was successfully hand-reared using Cat Milk Replacer (Wombaroo). Strongyle and coccidian eggs were identified on fecal floatation using 33% zinc sulfate solution. Gastrointestinal roundworm infection was successfully treated using Ivermectin 10mg/ml (Ivomec® 1% Injection for Cattle and Swine, Merial) 200µg/kg s.c., repeated in 21 days. Coccidiosis was successfully treated using Toltrazuril 25mg/ml (Baycox 2.5%, Bayer Healthcare AG) 5mg/kg orally, once a day for 3 days. Mortality rate in the centre (72.5%) remains high. Ulceration of oral, esophageal and gastric mucosa was the most commonly seen abnormality on necropsy, however, histologic analysis of these lesions (n=15) failed to elucidate an etiology. Future focus includes development of objective clinical health parameters, and investigation to determine the underlying causes of mortality in confiscated pangolins.

DEPLOYMENT OF THE ZOOLOGICAL INFORMATION MANAGEMENT SYSTEM (ZIMS)

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Abstract

International Species Information Systems (ISIS) has provided collections record-keeping software for zoos and aquariums since 1975. ISIS has 825 members in 76 countries. Members have access to the ISIS global database with information on 2 million terrestrial and aquatic animals.

Working with zoo and aquarium professionals, ISIS has been developing the ZIMS (Zoological Information Management System) application. It is a web-based system that integrates and expands upon all ISIS legacy programs (ARKS, SPARKS, and MedARKS). The ZIMS application expands the capacity of previous ISIS software, including providing management tools for animal groups and colonies, enclosures, complete functionality for aquariums, life support, and water quality measurements. ZIMS is role-based and customizable, so each user will have quick access to the functions that relate to daily tasks. When logged in as a veterinarian, details about scheduled procedures, active cases, prescriptions, and tests results will be easily accessible. The application's role-based security system and other protections assure only authorized users will be able to view these records. The result is a streamlined, powerful program that can replace and expand current record keeping methods.

The ZIMS application will be launched in phases, with the first release available to ISIS members in the spring of 2010. The second release, focused on medical functionality, will be available in the spring of 2011. The third release for species management will be available in the fall of 2011, and the fourth release with advanced functions for everyone will be available spring 2012. ZIMS training tools will be available online for ISIS members. Please see the ISIS website for more information: www.isis.org

MOLECULAR DIAGNOSTICS: BENEFITS, RESTRICTIONS AND COMMON PITFALLS

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Abstract

Molecular tools are exciting new diagnostic modalities used in a variety of areas of medicine including identification of infectious agents, evaluation of drug resistance, cancer detection, and prognosis. Molecular diagnostic techniques have become important supplements to conventional microbial identification and are particularly useful in non-domestic species as the assays target the pathogen negating the need for species-specific reagents. Most tests utilize polymerase chain reaction (PCR) based amplification of RNA or DNA targets as the basis of the assay. Commonly used techniques include PCR with sequencing of amplicons, real-time PCR, and more recently microarrays. Because of their sensitivity, specificity, and rapidity, the integration of molecular diagnostic techniques into routine diagnostics and pathogenesis research can enhance the diagnosis, treatment, and management of disease.

Molecular Tests

There are a variety of molecular techniques being utilized in a diagnostic setting. The most common include PCR and real-time PCR. Both techniques can be performed on RNA (in which case there is an initial reverse transcription step) or DNA extracted from a sample. With PCR, a positive result is identified either as a band of the appropriate size on an agarose gel or from sequencing the amplicon. False positives can occur if primers bind to non-target nucleotides (either non-specific binding or non-specific primers) resulting in a visible amplicon on a gel of an incorrect size, or possibly of the correct size. In the latter, sequencing of the PCR amplicon (product) provides an additional quality control measure to confirm the amplicon is the expected target. Real-time PCR utilizes fluorophores to quantify (either relative or absolute) the amount of target within a sample.[3,4] Many real-time PCR assays couple the fluorophore to a specific probe increasing the specificity of the assay. Real-time PCR assays are particularly useful for identification of common pathogens or genes. With microarrays, a clinical sample can be screened for a variety of pathogens, gene expression, as well as for drug resistance.[5] Pathogen microarrays typically contain sets of probes for strain, subspecies, species, genus, or higher taxonomic grouping. Microarray technology is more expensive and currently less available due to the requirement for specific equipment and arrays designed for the pathogens or genes of interest. Additionally there have been concerns about sensitivity in comparison with real-time PCR; however, future advances are expected to improve the utility of this technique in a diagnostic setting. It is critical to remember that molecular tests only test for the presence of

RNA or DNA and, in the case of pathogens, do not say anything about the viability of the organisms.

How to Get the Most from Your Sample

As with other diagnostic tests, submission of the correct sample is critical for obtaining the best result from a molecular test. Although obtaining samples can be challenging in non-domestic species, by considering the disease pathogenesis, judicious sample selection can optimize the concentration of your target and decrease the likelihood of a false negative result. Many tests utilize small volumes, typically less than 1 ml or 1 g and submission of large sample volumes is not necessary, but the submission should be representative. While the small sample size is a benefit of molecular tests, it is also a disadvantage if the sample is not obtained from the optimal site. For example, if testing a kidney for leptospirosis, it is important to sample an area of the kidney most likely to contain the organism. Blood can be tested for evidence of septicemia but again, the quantity utilized in nucleotide extractions is often small in comparison to the total blood volume of the animal and may not be representative of the process.

Once the appropriate sample is collected, it must be handled appropriately to ensure good quality RNA and DNA. RNA is more sensitive to degradation than DNA and caution should be taken with samples for RNA analysis (e.g. RNA viruses). Samples can be frozen immediately after collection or placed in preservative such as RNAlater (Ambion, Austin TX 78744-1832 USA). For blood samples, PAXGene tubes (PreAnalytiX, Franklin Lakes, NJ 07417 USA) are also useful for RNA preservation. Most samples for DNA can be shipped on ice packs; however, check with your individual laboratory for specific guidelines. If samples are collected for possible future testing, storage at -70^{o}C is best. To inhibit build up of frost, most –20^{o}C freezers go through freeze-thaw cycles that can damage RNA and DNA. Molecular tests can also be used on archived formalin-fixed paraffin embedded tissues in some laboratories. However formalin cross-links DNA causing it to break, restricting the size of the amplicon that can be obtained which can result in false negatives. Prompt processing of histologic samples into paraffin increases the chances of an accurate result.

Assay Validation

With the proliferation of new molecular tests, it is important that assays be appropriately validated. The American Association of Laboratory Diagnosticians (AAVLD) recommends following the World Organization for Animal Health (The OIE) principles for development, validation, and quality control for molecular diagnostic assays (see http://oie.int/eng/normes/MMANUAL/A_summry.htm). These guidelines include information on optimization and standardization of reagents, assay repeatability, determination of analytic sensitivity and specificity, assay performance characteristics, determination of diagnostic sensitivity and specificity, and interpretation of results. Although some steps in assay validation are difficult given small population sizes (e.g. diagnostic sensitivity and specificity), every effort should be made to follow these guidelines in development of a new diagnostic test. The guidelines also include information on general laboratory quality control standards. Although assays targeting pathogens can be used across a variety of species, limited knowledge of host

genomic DNA sequences can impact the utilization of assays in new species. Primers and probes should be checked for cross-reactivity with genomic DNA whenever new host species are tested and non-conforming results double checked for accuracy.

Generic Assays and Reference Libraries

When identifying unknown pathogens, generic or consensus primers are commonly used. These primers are designed by choosing areas of sequence similarity among closely related organisms (e.g. several isolates of a specific viral type). Identification of the targeted pathogen is then accomplished through sequencing of PCR amplicons and comparison of PCR products with reference libraries. One problem with these assays is that mixed infections can either result in unreadable sequence or one pathogen may obscure the presence of a second potentially more important pathogen. For example, a generic bacterial primer set may not work for identification of a sample from a non-sterile site or they may pick up a secondary colonizer rather than the real cause of a lesion. For these reasons, aseptic sample collection is as important in sampling for molecular as traditional culture based tests when using generic primers. Another difficulty with generic primer sets is the lack of a reference library for sequence comparison. Many of the commercially available validated reference libraries are biased towards pathogens of importance in human medicine.[1,2] Therefore, identification of some organisms requires utilization of other, less controlled, libraries that may include incorrectly identified sequences. Thus results of sequence comparisons are only as good as the reference library, a major limiting factor when working with non-traditional species about which there is limited knowledge.

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DISTINGUISHING PATHOGENIC FROM NONPATHOGENIC STRAINS OF *Mycobacterium avium* IN ZOO BIRDS AND THE ENVIRONMENT BY REAL-TIME PCR TARGETING IS901

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Abstract

Recent work suggests that *Mycobacterium avium* infections are not readily transmissible from bird to bird.[1,3-5] Instead, most infections are probably acquired independently from the environment. Determining which environmental compartments pose the greatest risk of infection requires a testing method that distinguishes pathogenic from nonpathogenic strains of *Mycobacterium avium* complex (MAC) organisms (particularly *M. avium* subspecies *avium*, *hominissuis*, and *intracellulare*). Such a test might also distinguish intestinal pass-through from true infection in birds with MAC positive fecal cultures. The insertion element *IS901* has been shown to correlate with pathogenicity of *M. avium* isolates.[2] A real-time PCR assay targeting the *IS901* gene was developed as a diagnostic tool for identifying pathogenic MAC strains in tissue samples and culture isolates from birds, as well as environmental samples. We analyzed a total of 104 cultured isolates of MAC from diseased (n=24) and non-diseased (n=29) birds for the *IS901* insert. All isolates from diseased birds were *IS901* positive strains of *M. avium* subspecies *avium*, while all isolates from non-diseased birds were *IS901* negative strains of M. *avium* subspecies *hominissuis*, indicating the potential value of this test in distinguishing intestinal pass-through from true infection. Samples of soil, water, and significant food items such as crickets and annelids were collected from 238 individual aviaries. More than 65% of all environmental samples contained *IS901* positive strains of *M. avium* subspecies *avium.* This suggests that birds are regularly exposed to potentially pathogenic mycobacteria, and progression to a disease state is likely to involve multiple risk factors.

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RECENT DEVELOPMENTS IN MARINE MAMMAL VIRUS DISCOVERY

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Abstract

Marine mammal virology is a nascent field. We know that the ocean harbors a huge diversity of viruses, but we have very limited knowledge as to which viruses marine mammals are susceptible. Our laboratory has focused on development of tools for virus discovery in these species and on assessment of clinical relevance of viruses that have been discovered using these tools. Some of the tools that have been most useful for virus discovery include consensus primer PCR and rolling circle amplification.

This work has resulted in the identification of over 50 new viruses from 13 different families. We have demonstrated at least one case of genetic recombination between a virus of humans and marine mammals. This virus belongs to an RNA-based virus family, the astroviruses, that frequently cause gastroenteritis in humans. It appears that much greater diversity is present in the astroviruses of marine mammals, and they may be a reservoir for these viruses.

Medicine has traditionally waited for viruses to cause epidemics or epizootics before significant surveillance occurs. With our increased understanding of virus ecology and evolution, it becomes more feasible to identify probable candidates for future novel disease outbreaks, and increase surveillance. Understanding of the marine ecosystem is necessary to comprehend viral ecology, and has great significance for terrestrial animal health as well.

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IS CANCER STILL THE KISS OF DEATH? NEW OPTIONS IN ONCOLOGY

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Abstract

Historically, a diagnosis of neoplasia in an exotic animal was made at necropsy or resulted in euthanasia of the animal. Rationale for euthanasia of the animal often included: advanced state of neoplasia at discovery; difficulty in administering and monitoring therapy in zoologic specimens; lack of access to advanced therapies such as radiotherapy; and expense of treatments. If treatment was attempted, it traditionally involved cytoreductive or curative surgical resection of the primary tumor, along with a course of corticosteroid treatment.

With the advent of advanced diagnostic and therapeutic technologies within zoological institutions, including increased preventive medicine examinations with better screening techniques, more options are available for the diagnosis and treatment of neoplasia. Recently, more animals have been treated for malignancies. Current examples include reports of treatment of a tenrec, African lions, a flamingo, a gorilla, a penguin, birds, a ground cuscus, ferrets, a sun bear, and a racer.[1-12]

Cancers such as lymphoma, mast cell tumor, osteosarcoma, and soft tissue sarcomas may now be more readily managed in zoological animals through minimally invasive procedures in conjunction with operant conditioning. Treatment options for neoplasia are more numerous and advanced than they have historically been, and are becoming more cost-effective. Options range from radiation therapy, intravenous chemotherapy through vascular access ports, oral chemotherapy to biomodulators such as molecularly targeted therapeutics. As zoological medicine continues to trend toward more preventive medicine and increased operant conditioning, prolonging the lives of cancer-affected animals will continue to become a realistic component of zoological medicine.

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EVALUATION OF SURGICAL TECHNIQUES AND INTERNAL SONIC TRANSMITTER IMPLANTATION IN STURGEON (ACIPENSERIDAE)

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Abstract

Surgical methods used for transmitter implantation should be carefully evaluated to determine their effect on fish.[1,2] In this study, 120 Siberian sturgeon (*Acipenser baerii*) were randomly assigned to four treatment groups. Each group was assigned a different suture material for coeliotomy closure: antibacterial poliglecaprone 25, poliglecaprone 25, polyglactin 910, and polypropylene. Fifteen fish in each treatment group also received an intracoelomic sonic transmitter. Thirty fish were subjected to the same handling procedures, but did not undergo surgery. To evaluate healing, five fish from each group were euthanatized and subjected to necropsy and histologic examination of the incision site at 1, 2, and 8 wk post surgery. Preliminary results indicate that significant healing occurred by 8 wk at 12.5^{o}C. Inversion of the incision was evident at 2 wk, and may be a result of the simple interrupted suture pattern or healing in this species. Varying degrees of erythema occurred during the initial 12 wk in all groups. Polypropylene exhibited expected retention, but both polyglactin 910 and polypropylene groups also exhibited suture retention up to 12 wk. The polyglactin 910 group suffered from higher rates of suture loss and dehiscence throughout the initial 8 wk, and signs of abnormal healing were still evident at 12 wk. Twenty-five percent of the transmitters were expelled predominately through the vent up to 12 wk after surgery. Our data indicates that either antibacterial poliglecaprone 25 or poliglecaprone 25 appears more appropriate for skin closure in the Siberian sturgeon, and intracoelomic transmitter expulsion appears more frequent than previously reported.[3-9]

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EFFICACY OF A PORTABLE OXYGEN CONCENTRATOR FOR IMPROVEMENT OF ARTERIAL OXYGENATION DURING ANESTHESIA OF WILDLIFE

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Abstract

Portable battery driven oxygen concentrators provide an alternative to the use of oxygen cylinders for treatment of hypoxemia during field anesthesia. We evaluated use of the EverGo™ Portable Oxygen Concentrator (Respironics®, Murrysville, Pennsylvania, USA) with fixed bolus delivery for improvement of arterial oxygenation during anesthesia of wildlife. This concentrator is a bolus driven device which delivers oxygen in a pulsed flow (pulse volume 12-70 ml) with a maximum capacity of 1.05 L/min. The pulse dose setting shall be adjusted according to the respiratory rate (RR) of the animal (e.g. setting 6 for a RR ≤15/min). The study included 16 free-ranging brown bears (*Ursus arctos*), seven free-ranging bighorn sheep (*Ovis canadensis*), and five captive reindeer (*Rangifer tarandus*). Oxygen was administered via two nasal lines that were inserted through the nostrils to the level of the medial canthus of the eyes. Arterial blood samples were collected before and during oxygen therapy and immediately processed with an i-STAT® Analyzer (Abbott Laboratories, Abbott Park, Illinois, USA). When providing oxygen from the portable concentrator, the arterial oxygenation markedly improved in brown bears and reindeer, whereas no improvement was seen in the bighorn sheep. The efficacy of the evaluated method may be influenced by ambient temperature, altitude, pulse dose setting on the concentrator, the animal's respiratory rate, and species-specific physiology during anesthesia (e.g. shunt fraction). Portable concentrators are user friendly, non-explosive devices that are rechargeable and produce oxygen at low cost, but further studies are needed to evaluate their efficacy in different species and capture settings.

EFFICACY OF THIAFENTANIL-DEXMEDETOMIDINE-TELAZOL FOR GREATER RHEA (*Rhea americana*) IMMOBILIZATIONS

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Abstract

Ratite immobilizations are often precarious, as their powerful legs are used as a defense, and physical restraint may result in self-injury or injury to handlers. Although various combinations of opioids, alpha-2 adrenoreceptor agonists, and dissociatives have been employed in ratites, including a thiafentanil-medetomidine combination used in emus, few effective chemical immobilization protocols have been documented for rheas.[1-3] In 2009, a novel cocktail consisting of 7.0 mg thiafentanil, 0.2 mg dexmedetomidine, and 100 mg Telazol was tested in eight adult (4four male, four female) greater rheas (*Rhea americana*) at Wildlife Safari drive-through zoo. A Dan-Inject carbon dioxide powered pistol was used to deliver the drug combination into the thigh musculature, using a Type C Pneu-Dart with a gel collar and ¾" needle. Smooth inductions were observed with a mean time of 4.5 min to sternal recumbency. Atipamezole was administered to antagonize the cardiopulmonary depressant effects of the dexmedetomidine. Birds were intubated and maintained on isoflurane gas during clinical procedures. Naltrexone was administered to antagonize the thiafentanil, and midazolam was administered to smooth crate recoveries until release. Mean time to sternal recovery was 2.5 min. Respiratory depression was observed in one animal with evidence of respiratory acidosis on blood gas analysis; however antagonists were administered and the animal recovered without incident. This low volume, high potency, reversible drug combination demonstrated safe inductions, smooth recoveries, and proved to be a reliable anesthetic regime for greater rheas.

ACKNOWLEDGMENTS

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COMPARATIVE ANALGESIC EFFICACY OF MORPHINE AND BUTORPHANOL IN KOI (*Cyprinus carpio*) UNDERGOING GONADECTOMY

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Abstract

In zoological medicine, understanding pain and analgesia is limited by our ability to define and measure pain, as well as our limited knowledge of analgesic drug efficacy and mechanisms of action. While few studies are available on fish pain and analgesia,[1,2,5,6] controversy exists regarding the ability of fish to experience pain.[3,4] Our objectives were to: 1) develop and validate an ethogram in koi (*Cyprinus carpio*), specifically to quantify nociceptive and antinociceptive behavior before and after unilateral gonadectomy; and 2) evaluate the safety, efficacy, and side effects of the opioid analgesics, butorphanol and morphine for post-surgical pain in koi. Adult koi (n=90) received either physiologic saline (0.09%), butorphanol tartrate (10 mg/kg), or morphine sulfate (5 mg/kg) in three treatment categories: drug only (n=6 for each drug), drug with anesthesia and surgery (n=12 for each drug), and drug with anesthesia, but without surgery (n=12 for each drug). Physiologic and behavioral data were recorded pre- and post-treatment. In addition, a blood sample was collected (0.1 ml) before anesthesia and after surgery to assess PCO_2 (mmHg), PO_2 (mmHg), pH, and lactate (mmol/L).

Of the koi undergoing surgery, those receiving only saline showed a marked decrease in interactive behavior, food consumption, and activity, which lasted for greater than 72 hr. In contrast, for those koi receiving either morphine or butorphanol, food consumption and interactive behavior had returned baseline values within 3 hr post-surgery. Activity for both butorphanol and morphine surgery groups significantly decreased from baseline following surgery, and returned to normal within approximately 48 hr post-surgery. Though statistically insignificant, post-surgical blood values increased for lactate and PO_2 and decreased for pH and PCO_2. In summary, koi undergoing unilateral gonadectomy without analgesics do not exhibit normal behavior, while both morphine and butorphanol appear to produce antinociception. Butorphanol administration was associated with the most significant respiratory depression compared to morphine or saline. In addition, most koi receiving butorphanol, regardless of surgery or sham, showed temporary, abnormal buoyancy characterized by the tail near the water surface and head directed toward the tank bottom. Thus, morphine appears to be the most appropriate choice for analgesia in koi.

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REVERSABLE CHEMICAL RESTRAINT OF NILE HIPPOPOTOMUS (*Hippopotamus amphibious* spp.)

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Abstract

The Nile hippopotamus has historically been difficult to chemically restraint in both the wild and in captivity. Current anesthetic protocols using a combination including concentrated opiods have been risky and have resulted in apnea, cyanosis, bradycardia and fatalities in up to 1/3 of the cases.[1]

In this study 13 hippopotamus, 3 captive and 10 wild hippopotamus, ranging in weight from 350 kg to 1800 kg were chemically restrained with a protocol using a combination of medetomidine, butorphanol and azaperone. The hippopotamus were anesthetized via remote injection utilizing a 10 cc Dan-inject dart with a 2.2 x 60 mm needle. Adult hippos were darted with a combination of medetomidine 0.04-0.05 mg/kg, butorphanol 0.10-0.12 mg/kg, and azaperone 0.08-0.10 mg/kg. Once anesthetized, vital signs were monitored via capnography, blood gas analysis, heart rate, respiratory rate, pulse oximetry and blood pressure every 5 min for 30 min. The hippopotamus were then reversed with an intramuscular injection of atipamezole (2 times the medetomidine dose) and naltrexone (2 times the butorphanol dose) with a 3.5 inch 18 gauge spinal needle in the neck or tongue. Induction time were was 8 ± 5 min and recovery time (until standing) was 10 ± 5 min. Total working time (from the time the hippo was darted handled until it was reversed) was 60 ± 6 min. Capnography and blood gas analysis were the most reliable monitoring tools. Overall this appears to be a successful anesthetic protocol but additional anesthetic events will allow for a more refined technique.

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CARFENTANIL-XYLAZINE ANESTHESIA IN THE OKAPI (*Okapia johnstoni*): 20 + YEARS OF EXPERIENCE

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Abstract

Complications associated with anesthesia are still one of the most significant causes of adult morbidity and mortality in the international captive okapi (*Okapia johnstoni*) population (Citino, personal observation).[5,6] The most common anesthesia-associated problems reported in okapi are regurgitation and aspiration of rumen contents and post-anesthesia gastrointestinal stasis or ileus (Citino, personal observation).[6] The most common chemical restraint protocols used to induce recumbency in okapi utilize either an opioid (etorphine, carfentanil) in combination with an α_2-adrenergic agonist (xylazine, detomidine) or medetomidine-ketamine.[1-6] This abstract reports on anesthesia data collected over 20 + yr on captive okapi at White Oak Conservation Center, Yulee, FL and the Okapi Conservation Project, Epulu, Democratic Republic of Congo.

One hundred thirty successful anesthesias in 42 okapi (22 males:20 females) have been performed without mortality using xylazine and carfentanil in a staged technique. Xylazine is given first by dart or polesyringe at a dose of 0.14±0.03 mg/kg (Adult total dose = 30 mg min, 50 mg max) im and is followed in 15-20 min with carfentanil at a dose of 4.62±0.72 µg/kg (adult total dose = 0.9 mg min, 1.8 mg max) im. The better the initial sedation by xylazine, the smoother the induction will be. Azaperone (0.15-20 mg/kg) can be added to xylazine to improve inductions in problem animals. For okapi receiving significant stimuli during anesthesia (e.g., electroejaculation), ketamine (1.0-1.5 mg/kg) can be added to the carfentanil to potentiate the xylazine-carfentanil combination. Xylazine, ketamine, and 5% guaifenesin solution have been used to supplement anesthesia. Anesthesia is reversed with naltrexone and tolazoline, yohimbine, or atipamezole. Renarcotization occurs sporadically.

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COMPARISON OF LARYNGEAL MASK AIRWAY USE WITH ENDOTRACHEAL INTUBATION DURING ANESTHESIA OF WESTERN LOWLAND GORILLAS (*Gorilla gorilla gorilla*)

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Abstract

The laryngeal mask airway (LMA) is an alternative to endotracheal intubation used in human medicine as a means of airway control.[1,2] This study compared use of the laryngeal mask airway with endotracheal intubation in western lowland gorillas (*Gorilla gorilla gorilla*) under general anesthesia. Seven adult gorillas, 5 females and 2 males ranging in age from 5 to 23 yr, were included in this study. Gorillas were immobilized for routine examination with tiletamine/zolazepam (Telazol, Fort Dodge Animal Health, Fort Dodge, Iowa, 50501) given intramuscularly via hand injection or remote injection at doses between 3.16-4.36 mg/kg. Three gorillas were intubated and four gorillas were fitted with a laryngeal mask airway (Ambu AuraOnce - Single Use Laryngeal Mask, Ambu A/S, Denmark). Sevoflurane (Petrem, Minrad Inc., Bethlehem, PA, 18017) was used for anesthetic maintenance, 1-7% to effect delivered in 100% oxygen via rebreathing circuit. Parameters measured and compared between the two groups included: time of airway device placement, pulse oximeter oxygen saturation (SP02), end-tidal carbon dioxide (EtCO2), heart rate, respiratory rate, arterial blood pH, pO2, and pCO2. There were no statistically significant differences in time of airway device placement, heart rate, EtCO2, arterial blood pH, and pCO2. The LMA group had a statistically significantly greater SP02 10 min after airway device placement, and greater pO2 15 and 45 min after placement. Respiratory rate was greater in the endotracheal intubation group at several time points. The laryngeal mask airway is an effective alternative to endotracheal intubation in Western lowland gorillas.

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REVERSIBLE ANESTHETIC COMBINATION WITH BUTORPHANOL, MEDETOMIDINE AND MIDAZOLAM IN FREE-RANGING AFRICAN LIONS (*Panthera leo*)

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Abstract

The combination of medetomidine, butorphanol and midazolam (BMM) has been used successfully to immobilize domestic and exotic carnivore species, such as red wolf (*Canis rufus*), African wild dog (*Lycaon pictus*), and cheetah (*Acinonyx jubatus*).[1-4] The aim of this study was to evaluate the effects of BMM and its reversibility using naltrexone, atipamezole and flumazenil in free-ranging lions.

Thirty lions, 10 male and 20 female, were anesthetized using 0.31 ± 0.034 mg/kg butorphanol (Butorphanol 50mg/ml, Kyron Laboratories (Pty) Ltd, Benrose, South Africa), 0.052 ± 0.006 mg/kg medetomidine (Medetomidine 20mg/ml, Kyron Laboratories (Pty) Ltd, Benrose, South Africa), 0.21 ± 0.024 mg/kg midazolam (Midazolam 50mg/ml, Kyron Laboratories (Pty) Ltd, Benrose, South Africa) and 1250 IU hyaluronidase (Hyalase, Kyron Laboratories (Pty) Ltd, Benrose, South Africa) administered intramuscularly with a dart gun. Once recumbent, physiologic parameters and anesthetic depth were monitored, and arterial blood gas analyses were performed. Anesthesia was reversed 45-60 min after initial darting with 0.68 ± 0.082 mg/kg naltrexone (Naltrexone, 50 mg/ml, Kyron Laboratories, Benrose, South Africa), 0.26 ± 0.031 mg/kg atipamezole (Antisedan, Orion Pharma, Espoo, Finland) and 0.0032 ± 0.0007 mg/kg flumazenil (Anexate, Roche Products, Isando, South Africa) administered intravenously and subcutaneously.

The drug combination provided safe and reliable immobilization with minimal cardio-respiratory changes in healthy lions of both sexes. Blood gas analyses revealed a mean pH of 7.333, $PaCO_2$ of 33 mmHg and PaO_2 of 87 mmHg. Mild to moderate hypoxemia was seen in four lions. Induction and recovery phase were both rapid (less than 10 min) and smooth, making the combination ideal for field work.

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RISK FACTORS ASSOCIATED WITH PERIANESTHETIC MORTALITY OF REHABILITATING CALIFORNIA SEA LIONS (*Zalophus californianus*)

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Abstract

The objective of this retrospective case-control study was to identify risk factors that may predispose rehabilitating California sea lions (*Zalophus californianus*) to perianesthetic mortality. Hospital records of 281 California sea lions that underwent sedation or general anesthesia while at a rehabilitation center in California from 2004 through 2008 were reviewed, including records from 419 anesthetic events. All California sea lions that died (n = 15) during or in the subsequent 72 hrs of anesthesia were classified as cases. All sea lions that survived (n = 404) were classified as controls. The following risk factors for anesthetic death were reviewed: gender, age class, health status, duration of anesthetic period, atropine premedication, induction protocols, and maintenance protocols.

The prevalence of mortality during anesthesia was 3.1% (n = 13) over the 5-yr period. With the inclusion of animals that died within 72 hrs post-anesthesia, the total mortality prevalence rose to 3.6% (n = 15). The only factor associated with increased odds of anesthetic-related death was premedication with atropine, whereas good health status was protective and associated with reduced odds. The most common time of death was during anesthetic maintenance. Results suggest that the use of atropine as a premedication should be avoided. Understanding risk factors associated with anesthetic-related deaths in pinnipeds will help veterinarians identify high-risk patients and improve patient care during anesthesia.

THE ANIMAL WELFARE ACT AND BIRDS

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Abstract

Veterinarians and veterinary health technicians employed by the Animal Care Program (AC) of the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) are located throughout the country serving as inspectors of wholesale dealers, breeders, transporters, and exhibitors of animals to ensure the health and welfare of the animals under the Animal Welfare Act (AWA). In 2002, the passage of the Farm Security and Rural Investment Act amended the AWA's definition of animal to include rats of the genus *Rattus*, mice of the genus *Mus*, and birds other than those bred for use in research. Since then, the USDA has been working on regulations to implement this change in law. This talk provides a review of the history of the AWA and its enforcement, as well as an update on the process of changing the regulations to provide for the humane care, treatment, and handling of birds in AC regulated entities.

Background: The Act, the Definition of Animal, and the Regulations

The history of the Animal Welfare Act began in 1966 when Congress passed Public Law (PL) 89-544, the Laboratory Animal Welfare Act. This law was designed to regulate dealers of dogs and cats and oversee laboratories that perform research using dogs, cats, hamsters, guinea pigs, rabbits, or nonhuman primates. The Act was amended in 1970 (PL 91-579), changing its name to the Animal Welfare Act (AWA) and giving the Secretary of Agriculture the ability to regulate other warm-blooded animals used in research, exhibition, or the wholesale pet trade. An amendment in 1976 (PL 94-279) provided for the prohibition of most animal fighting operations and for the regulation of commercial transport of animals. The Improved Standards for Laboratories Act (part of the 1985 Food Security Act, PL 91-198) enabled the Secretary of Agriculture to expand standards for laboratory animals. In 1990, the Food Agriculture, Conservation, and Trade Act included provisions for pet protection by adding regulations regarding random-source pets, i.e. dogs and cats that were obtained from shelters or people who did not breed or raise them. The Federation Aviation Administration reauthorization bill of 2000 required commercial air carriers to report to the Department of Transportation any incidents involving the loss, death, or injury of an animal in transit.

Under the original AWA from 1966, animal was defined to include dogs, cats, nonhuman primates, guinea pigs, hamsters, and rabbits. In 1970, that definition was expanded to include any warm-blooded animal used, or intended for use, in research, exhibition or as a pet. Horses not used for research and other farm animals intended for agricultural purposes (i.e. for fur, skins, or food) were excluded from coverage under the AWA. The USDA amended the

definition of animal in 1971 to exclude birds, rats of the genus *Rattus*, and mice of the genus *Mus*. In 1989 that definition was further amended to exclude only rats and mice bred for use in research. Because of the way the exclusion was worded, it was interpreted by USDA that all birds would be excluded from coverage under the AWA. This interpretation remained until 2002 when, due to political pressure and a lawsuit filed by the Alternative Research and Development Foundation, the Farm Security and Rural Investment Act (PL 107-171) was passed. Also called The Farm Bill, this act specified that the exclusion of coverage under the AWA only apply to rats of the genus *Rattus*, mice of the genus *Mus*, and birds bred for research.

The USDA/APHIS Animal Care Program is tasked with creating and enforcing regulations implementing the AWA. These regulations are found in Title 9, Code of Federal Regulations (CFR), Chapter 1, Subchapter A, Parts 1-3 and require the licensing and inspection of dealers, exhibitors, and operations of animal auction sales. The first part contains definitions used in the regulations, the second part discusses administrative requirements for enforcement of the act, as well as the responsibilities of the regulated parties, and the third part specifies requirements and standards for the humane handling, care, treatment, and transportation of animals covered by the AWA. There are 6 subparts (A-F) within part 3. Subparts A-E list standards for dogs, cats, guinea pigs, hamsters, rabbits, nonhuman primates, and marine mammals. Subpart F covers other warm-blooded animals not listed in A-E.

The USDA/APHIS Animal Care Inspection Process

Any facility that houses animals covered under the AWA is required to be licensed or registered with APHIS and is also subject to unannounced inspections. Inspectors can either be veterinarians, called Veterinary Medical Officers, or animal health technicians, called Animal Care Inspectors, and are trained to evaluate facilities thoroughly for noncompliance in areas affecting the welfare of the animals housed therein. Main aspects of the inspections include the following: housing, ventilation, lighting, interior surfaces, primary enclosures, sanitation, pest control, feeding and watering, outdoor shelter, compatibility (e.g. cage mates, shelter from view of other animals to reduce stress, access of unweaned animals to their mothers), veterinary care, record-keeping, handling, and transportation. The owner of the facility typically accompanies the inspector and any violations are discussed, along with a deadline to correct any areas that are in noncompliance. If this deadline is not met, legal action may be taken, including confiscation and rehousing of the affected animals.

Advanced Notice of Proposed Rulemaking: the USDA Solicits Input from Avian Stakeholders

In 2004, the USDA released an advance notice of proposed rulemaking (ANPR) and request for comments on the creation of regulations that would cover birds other than those bred for use in research. This would include all birds "sold as pets at the wholesale level, or transported in commerce, or used in exhibition, research, teaching, testing, or experimentation purposes." In the ANPR, the USDA acknowledged that there are over 9000 species of birds, representing over 30 orders, with many unique husbandry requirements. Because of this, the general standards as they were currently written in subpart F of Part 3 of the regulations would be insufficient to

provide for the humane handling, care, and treatment of birds. Input was solicited on standards for birds under subpart F, as well as changes required to Part 2 specific to birds. The advanced notice was very specific on the information needed based on what was already listed in Subpart 3 for mammals:

- Potential numbers and sizes of entities that would be covered under the change in regulations, as well as the types and numbers of different species found in these entities.
- Facilities and operations, including caging and construction, space external to housing, waste disposal, heating, ventilation, lighting, and substrate for both indoor and outdoor facilities.
- Animal health and husbandry, including classification and identification of animals, diet, sanitation, separation from stressors, and housing with compatible animals.
- Transportation, including specifications for enclosures and carriers, terminal facilities, and feeding, water, and care of animals in transit. Under §2.130 are minimum age requirements for commercial transport of dogs and cats, and the advanced notice requested input on whether there should be similar provisions for birds.
- Types of biosafety precautions inspectors should take at avian facilities, both for their own safety as well as the safety of the birds.

Comment was also solicited regarding changes in exemptions for certain facilities. Under §2.1 and §2.25 of the regulations, licensing and registration is required for all dealers, operators of auction sales, and carriers and intermediate handlers other than retail pet stores selling non-dangerous animals intended as companions. Thus, the USDA requested input on whether or not there were specific avian entities that should be similarly exempted. Given all these potential changes, information was also solicited on the potential financial impact the proposed rule would have on the industry.

There were over 7,400 comments submitted in response to the advance notice, representing input from a wide range of representatives from entities working with birds, including breeders, zoos and aquaria, research laboratories, dealers, animal welfare organizations, trade associations, and private citizens. These comments were evaluated and incorporated into the proposed regulations, often referred to as the Bird Reg.

The Bird Reg: What's Next?

Currently the Bird Reg is undergoing internal review, after which it will be released to the public, along with solicitation for comments on these changes. Those changes will be reviewed and incorporated into the final rule which will again undergo internal review. Once that process is complete, a final rulemaking will be published. The ultimate product will rely on scientific research wherever possible and incorporate input from a broad range of experts in the field in order to provide captive birds with optimized humane care, treatment, and handling under the AWA.

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All materials used in this manuscript are available online at the website for the Animal Care program of the USDA/APHIS (http://www.aphis.usda.gov/animal_welfare/index.shtml) or upon request.

HEPATOPATHY IN ZOO LORIINAE: IS DIET-INDUCED HYPERVITAMINOSIS A THE CAUSE?

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Abstract

Public walk-through lory and lorikeet aviaries remain a popular exhibit in U.S. zoological parks. From a veterinary perspective, these exhibits can be "high maintenance" with relatively high morbidity and mortality. In addition to trauma secondary to conspecific aggression, a variety of infectious disease problems have been reported.[1] The Louisville Zoo has observed a high incidence of hepatopathy in its lorikeet flock with 15/34 (44%) pathology cases having histologic evidence of acute or chronic hepatic degeneration, hepatitis, necrosis, and/or fibrosis/cirrhosis. Affected birds may present with lethargy, anorexia, weight loss, regurgitation, central nervous system signs, and/or hypoalbuminemia and ascites. A chronic hepatopathy has been recently presented as a wide spread disease problem in numerous birds from multiple U.S. facilities.[1] An etiology has not been identified but nutritional issues, or exposure to a hepatotoxin or virus is suspected.

Loriinae are reported to naturally consume a diet high in vitamin A precursors (i.e., carotenoids like beta-carotene) rather than foods high in preformed vitamin A.[4-6] Excessive vitamin A (>1000 IU/kg) in captive diets have been implicated to lead to health problems, including infertility, beak and feather pigmentation abnormalities, and immunosuppressive disease.[4-6] Diet analysis demonstrated that the diet fed to birds at the Louisville Zoo had high levels of vitamin A. Liver analyses of affected birds revealed that hepatic vitamin A concentrations were elevated, when compared to the limited data available for wild Loriinae. Vitamin A is a documented hepatotoxin.[2,3] Studies are on-going but we suggest that dietary vitamin A excess may contribute to hepatopathy in this taxon.

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SURGERY OF THE AVIAN BEAK

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Abstract

The avian beak is a unique anatomic and physiologic structure. It is subject to trauma and abnormal growth. Traumatic beak injuries can be closed primarily or managed open to heal by second intention. Because the beak and its bone in small birds is so thin, it is difficult to achieve primary healing. Birds adapt well, even if part of or the entire upper or lower beak is lost, and are generally able to eat and drink without assistance. Beak deformities occur secondary to trauma or, in baby birds, are developmental abnormalities. If caught early, the prognosis for young birds with deformities is good. Currently there are no reports of long term success using any type of implants to affix prosthesis for birds that have lost a section of beak.

Anatomy and Physiology

The upper and lower beaks are composed of bone covered by a horny sheath called the rhamphotheca. The rhamphotheca is further differentiated into the rhinotheca (keratin over upper beak) and gnathotheca (keratin over lower beak). The tomia are the cutting edges of the beak. The anatomy is typical of dermal bone as the dermis is attached to the periosteum and is covered by stratified squamous epithelium. The stratum corneum is particularly thick and very hard. The hardness is caused by an increase in free calcium phosphate and hydroxyapatite. Just like skin, there is a constant turn over of the keratin on the surface of the beak. The stratum germinativum produces daughter cells that migrate to the surface. Combined with the effects of transitional cells a specific pattern of cell migration develops in columns at various angles toward the tomia. In addition, the growth pattern is generally from the base of the beak to the tip.

The bones of the upper beak include the premaxilla and nasal bones. The upper beak is hollow in most species containing the rostral diverticulum of the infraorbital sinus. The bone itself is quite thin, the strength derived from the special keratin produced on the surface. In psittacines, the upper beak is attached to the skull by the craniofacial hinge, which is a synovial joint allowing the upper beak to move independent of the skull. The base of both the upper and lower jaw bones is covered by normal skin with or without feathers depending on the species. Birds may generate very high pressures when they bite potentially exceeding 200 p.s.i. in macaws.

Beak Trauma

Most traumatic injury to the beak can be classified into four types; simple fracture, depressed fractures, fractures with bone defects, and avulsion fractures. Beak injury can be difficult to treat because of some inherent problems. The bone is quite thin so bone purchase for fixation devices

is limited. The blood supply to the dermal bone of the beak is tenuous. There is very little soft tissue coverage to protect the bone. Fractures are difficult to stabilize especially in light of the extreme forces they are subjected to. And they are often contaminated with a high potential for infection, which will affect healing.

Crush injury to the beak is most commonly associated with bite injury from another bird or another household pet. They are often associated with missing fragments and depression fractures. They are not only contaminated by environmental and endogenous flora, but also the bacterial flora from the animal that caused the injury. And the bite can be associated with vascular compromise from the crushing effects of the bite. This type of injury is best treated using temporary stabilization until the tissues are healthy. Treat site as an open wound and apply stabilization after the tissues are healthy.

Simple clean fractures can be closed primarily if the tissues appear healthy and minimally contaminated. Successful healing depends on the ability to stabilize the fragments against the forces applied to them. Small patients are particularly difficult to stabilize adequately. Basic principles of fracture stabilization apply to fractures of the beak (rigid fixation, anatomic alignment, and early return to function). Methods of stabilization that have been applied successfully to bird beaks include pins and orthopedic wires, modified external skeletal fixation devices, and bone plates and screws.

Bone plates and screws have not been used much historically because the bone of the beak is so thin and has virtually no soft tissue coverage. The thin bone of the beak in most birds does not provide adequate screw purchase. Plates may be used in large birds with fractures of the caudal mandibular beak where the bone is thicker and covered by muscle and normal skin. Another potential application would be on top of the keratin surface of the beak. Used in this manner the plate acts more like an external fixator because the device is outside the body tissues while the screws into the bone maintain reduction. Necrosis of the epidermis under the plate is likely but if the fracture heals quickly the bone will potentially reepithelialize.

Intramedullary pins and orthopedic wires are also difficult to apply to the avian beak because there is no distinct medullary canal within the flat bones of the beak and the paucity of soft tissue over the bone would result in wires being exposed. Interfragmentary wires alone are generally inadequate to stabilize and counter the forces acting on the fracture; however, they will hold fragments in opposition. One technique using pins and wires that works well in some beak fractures involves placement of a pin across the fracture and a figure 8 wire around the pins. Applied to the tension side of the fracture, this type of stabilization can result in fracture compression. This construct can be made even stronger by applying polymethylmethacrylate bone cement over the surface to hold the components rigidly in place.

External skeletal fixation is readily applicable to beak fracture stabilization. Because of the thin bone of the avian beak, fixation pin purchase is not good. It is best to place fixation pins through both sides of the beak using the unaffected side as an anchor for improved pin purchase and better fracture stabilization. This is generally not possible for caudal mandibular fractures because of the tongue. Threaded pins also offer improved purchase. Fixation pins are connected

with acrylic cement on either the external and/or lingual surface of the beak. The Beak Repair Kit by Ellman International (Ellman International Inc, Oceanside, NJ 11572, USA) contains various splints and meshes along with acrylic cements useful for avian beak repair.
Beak bonding is analogous to dental bonding as done in mammals. The upper and lower beak are wired or cemented together using the unaffected beak to support the fractures. The beaks can be wired together or the Ellman splints and acrylic can be used to bridge between the beaks. An esophagostomy tube must be placed first and vomiting or regurgitation can result in life-threatening aspiration pneumonia.

Some fractures have devitalized or missing pieces of beak. The unhealthy tissue must be removed. With contaminated injuries, closure is delayed until the tissue is healthy. The area surrounding the defect is cleaned and roughed. A motorized rotary woodworking tool is especially useful for this. The acrylic is applied over the defect onto the clean, roughened rhamphotheca. The tissue will granulate and re-epithelialize under the acrylic. Eventually, the acrylic patch will slough off due to the normal turn over of keratin leaving a healthy beak below. If pieces are missing, the plastic mesh splint material works well to provide scaffolding over which the acrylic is applied. The rhamphotheca is cleaned and roughened as described above. The cement is used to secure strips of plastic splint over the defect onto healthy beak. Once the defect is covered with plastic mesh splint, acrylic is used to cover over the mesh and onto healthy beak.

A split mandible is a common beak injury occurring most often in small psittacine birds. The mandible splits at or near the rostral midline. This type of injury is very difficult to get to heal primarily. Most commonly, the two halves heal separately and never unite. The epithelium migrates over the fracture ends resulting in two separate halves of the mandible. Unfortunately, the author has not been able to develop a technique that consistently results in fracture healing. Because of the poor prognosis for fracture healing it is difficult to recommend orthopedic intervention. Fortunately, these small birds recover from this injury quickly and learn to eat with a permanently split mandibular beak. Some birds may need nutritional support until they are able to eat on their own. Pain medications are also indicated and may speed recovery.

Beak avulsion is another common traumatic injury seen with some degree of frequency. It usually occurs when one bird tears the beak off of another bird at its base. Attempts to reattach the beak are uniformly unsuccessful. Most birds adapt and are able to function while missing either the upper or lower beak. They may require nutritional support, which may include an esophagostomy feeding tube, until they learn to eat with the defect. Though some birds will fail to adapt it is worth giving them a chance. Many seem to do better when missing the mandibular beak.

Luxation of the palatine bone occurs primarily in macaws and is characterized by persistent hyperextension of the premaxilla. It appears that when the bird is startled and suddenly hangs from the upper beak, the palatine bone locks on the vomer bone preventing the bird from closing its mouth. Reduction is accomplished by inserting a Steinmann pin through the base of the premaxilla to use as a handle. The beak is hyperextended even more freeing the palatine bone from the vomer bone. Downward pressure is applied to the pin and the upper beak gently closed

down with respect to the lower beak. To prevent recurrence, the jugal bone is sutured to the infraorbital rim.

Beak Deformities

Scissor beak (lateral deviation of the premaxilla to the right or left) and mandibular prognathism (mandible longer than the premaxilla) are the two common types of beak deformity encountered in birds. Proposed etiologies include malposition in the egg, syringe feeding on only one side, genetics, and nutritional imbalances. Scissor beak tends to occur primarily in macaws while mandibular prognathism occurs primarily in cockatoos. Physical therapy can be successful in correcting the problem if instituted early enough; when the bone is still pliable before it is well mineralized. It involves repeatedly and frequently applying pressure to oppose the abnormal growth. For example, if the beak is deviating to the right, pressure is applied on the right side toward the left side. For scissor beak, it is recommended the bird be fed consistently on the opposite side until the deviation is corrected.

If the bird is too old or physical therapy fails, intervention is required. There are two basic methods used to correct scissor beak, the acrylic ramp and the pin and rubber band techniques. With the acrylic ramp technique, a ramp is applied to the surface of the beak to apply force to the beak every time it closes forcing it in the opposite direction thereby straightening the beak. The gnathotheca is scarified to improve the bonding of the cement to the beak. Circular wires are applied to the gnathotheca to serve as anchors. The wire mesh splint is secured to the gnathotheca with cement. Acrylic is added to create a ramp high enough so the maxilla cannot slide over to the affected side. A rotary tool is used to smooth and contour the ramp as well as to create a notch into which the premaxilla will rest. As an example, if the premaxilla deviates to the right, the ramp is created on the right side as well. Every time the beak closes the ramp forces the premaxilla to the left, toward the midline.

With the pin and rubber band technique a Steinmann pin is placed through the base of the premaxilla. A hook is bent on the end of the pin on the side opposite to which the beak is deviated. A notch is created in the tip of the premaxilla and a rubber band is placed from the hook on the pin to the notch on the beak. The rubber band is secured with cement to prevent it from slipping off. The rubber band applies constant tension to the tip of the premaxilla correcting the deviation. This method usually corrects the deviation more quickly but must be monitored carefully as over-correction can occur.

Both methods used for scissor beak are applicable to prognathism as well. With mandibular prognathism, the acrylic ramp is built on the rostral end of the premaxilla so that it extends beyond the rostral aspect of the mandible. The same procedure is followed for application of the ramp. With the ramp on the rostral aspect of the premaxilla, when the beak closes, the premaxilla is forced more rostrally. As the beak grows, the premaxilla will grow out so that ultimately it properly opposed the mandibular beak. Using the pin and rubber band technique, the pin is again placed at the base of the beak. The ends of the pin are bent rostrally and dorsally with hooks added. The rubber band is connected to the hooks and to the tip of the beak to apply tension to the tip of the premaxilla, correcting the malformation.

The younger the bird is the more rapidly the defect will correct. As the bird matures and the beak mineralizes it takes more time to correct the deviation. These devices must be closely monitored. Owners should also be educated to check the device to assure it is secure, functioning properly, and that the bird is developing properly. Once the beak is properly aligned the device must be removed to prevent over-correction. A rotary tool is used to bur away the acrylic cement to allow it to be removed from the bone. If wires were placed through the beak for added security, bur the cement to expose the wires so they can be cut and removed. The holes quickly granulate in and reepithelialize.

Prostheses

Prosthetic beak replacements are often considered for birds missing part of the beak. There are various reports of methods for creating beak prostheses. It would be ideal to be able to create a permanent prosthesis that would function normally for the life of the bird. Unfortunately, none of the supposed permanent beak prostheses can claim long-term success. The strong forces acting on any type of beak prosthesis will eventually result in it falling off. Prostheses applied to the surface of the beak will eventually be lost due to the natural turn over of the keratin surface. Prostheses implanted into bone will eventually fail due to cycling resulting in bone resorption and/or implant failure. If there is bone resorption, subsequent attempts to apply a prosthesis will generally fail more quickly because there is less bone stock. At the present time, there is no known permanent beak prosthesis applicable to birds.

Temporary prostheses may be used if needed. The best results are achieved using devices applied to the surface keratin, as they do not affect the remaining tissues. Unfortunately, they do not last long as they fall off when the keratin they are applied to sloughs. These prostheses also require that there is sufficient beak left to which the prosthesis can be applied. If the beak was avulsed and there is not base, there is nothing to which the prosthesis can be secured.

Prostheses secured with implants such as screws or threaded pins will generally last longer. Unfortunately, they result in bone resorption and are predisposed to infection because the implants are placed through a contaminated surface (the surface of the beak) into viable bone tissue.

PHARMACOKINETICS OF ORAL VORICONAZOLE IN MAGELLANIC PENGUINS (*Spheniscus magellanicus*)

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Abstract

Aspergillosis is a common cause of illness and mortality in captive penguins.[3] Voriconazole (Vfend™, Pfizer Pharmaceuticals, New York, NY 10017 USA) is a second-generation triazole drug with broad spectrum antifungal activity including against *Aspergillus* spp.[6,7] Avian voriconazole pharmacokinetic studies are limited[1,2,5,8,10] and there are no published studies for penguins.

Fifteen adult magellanic penguins (*Spheniscus magellanicus*) were given a single oral dose of 2.5 mg/kg voriconazole in a fish. Blood samples were taken at 0.5, 1, 2, 4, 8, 12, and 24 hr post administration. Each bird was bled a maximum of 3 times in a 24 hr period. Ultra performance liquid chromatography was used as previously described to measure plasma concentrations.[4] Data points for each time point were averaged for non-compartmental analysis. Mean plasma concentrations were above the targeted minimum inhibitory concentration (MIC=1.0 µg/ml)[9] for a short time (0.6 hr) and the long mean elimination half-life (15.1 hr) indicated potential for drug accumulation with multiple doses.

Further studies using higher and multiple dose administration are needed before making therapeutic dosage recommendations. In addition, it is important to note that the targeted MIC is based on in vitro susceptibility patterns, and it is not known how in vitro susceptibilities correlate with therapeutic efficacy in birds. However, using this preliminary information, an adult penguin with confirmed aspergillosis responded favorably (resolution of both clinical signs and leukocytosis) to a voriconazole treatment cycle of 5 mg/kg s.i.d. for 5 days then 1 day off treatment. The day off treatment helped prevent signs of suspected drug accumulation (anorexia).

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PHARMACOKINETICS OF A LONG-ACTING FORMULATION OF CEFTIOFUR (CEFTIOFUR CRYSTALLINE FREE ACID) ADMINISTERED INTRAMUSCULARLY IN THE RINGNECK DOVE (*Streptopelia risoria*)

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Abstract

Ceftiofur crystalline free acid (CCFA) (EXCEDE®, Pfizer Animal Health, New York, NY 10017 USA) is a third generation, oil-based, cephalosporin antibiotic marketed as a once weekly injection in cattle and swine and a two-time dose for a ten day duration in horses.[1,3-5] Long-acting antibiotic preparations are particularly useful for non-domestic species, though few have been documented in birds.[2] This study evaluated the pharmacokinetics of CCFA in ringneck doves (*Streptopelia risoria*) as a model for other avian species. A single intramuscular injection of 50 mg/kg CCFA was administered to 30 doves. Blood was collected from six birds at each of the following times: 0, 0.5, 1, 2, 4, 8, 12, 24, 48, 72, 96, 120, 144, 168, and 192 hr post-injection. One additional group of six birds served as the untreated control. Birds were euthanatized at the conclusion of the study and complete post-mortem and histopathologic examination of tissues was performed. Results indicate plasma concentrations remain above the minimum inhibitory concentration, for most avian pathogenic bacteria (1 μg/ml),[6,7] for at least 96 hr. Minimal gross pathologic changes were observed, including very mild tissue inflammation at the injection site. Based on preliminary results and histopathologic findings, a single intramuscular injection of 50 mg/kg CCFA appears to be a safe, long-acting antibiotic for ringneck doves and may be of use in other avian species.

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This study was reviewed and approved by the Wildlife Conservation Society's Institutional Animal Care and Use Committee: Project Number 09:04

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UNDERSTANDING THE AVIAN SHOULDER: ANATOMY AND PATHOLOGY OF THE CORACOID

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Abstract

The coracoid is one of four bones in the avian pectoral girdle. It is a short, thick bone connecting the sternum to the shoulder such that the ventral coracoid articulates with the cranial part of the sternum and the dorsal, distal coracoid articulates with the scapula to define the glenoid cavity. The sterno-coracoid articulation is an elongate synovial joint that permits both hinge-type movements and mediolateral gliding.[1] The sternal surface of this articulation is a narrow, curved groove in which the proximal coracoid glides.[2] The coracoid, by way of soft tissue attachments, is involved in rotation, depression, elevation, and protraction of the humerus, elbow and forearm flexion, manus and alular extension.[5,6,8]

Studies have shown that coracoid injuries often yield a characteristic flight pattern described as an inability to gain altitude while flying only short distances, low to the ground. This is most likely due to an inability to raise the injured wing above the shoulder. Wing droop may or may not be present. Concurrent soft tissue trauma often results.[4,5]

Coracoid fractures are common, and their repair has been described.[3,4] However, the diversity of fracture types is poorly defined in the literature and differential prognoses for proximal, mid-shaft and distal fractures are poorly understood.

Coracoid luxations are less common and are said to have a poor prognosis.[7] However, the authors believe coracoid luxations carry a fair to good prognosis depending on variables such as wing loading. Successfully rehabilitation of birds with such luxations is reported or is currently in progress (Uman and Pokras, unpublished).[3] Coracoid luxations can be difficult to identify radiographically and orthogonal views are important for evaluation. Post-release studies are needed to document the survival of these birds as well as to determine any long-term osteoarthritic changes that may occur.

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ECHOCARDIOGRAPHIC ASSESSMENT IN ADULT SADDLE-BILLED STORKS (*Ephippiorhynchus senegalensis*): NORMAL AND ABNORMAL FINDINGS

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Abstract

Echocardiogram assessments have been conducted on a routine basis at the Jacksonville Zoo on the saddle-billed storks (*Ephippiorhynchus senegalensis*) for the past 4 yr. In 2006, a 16-yr-old female stork was diagnosed with a grade 4-5/6 holosystolic murmur. An echocardiogram was performed which revealed severe mitral regurgitation with marked left atrial enlargement. No radiographic evidence of pulmonary edema or ascites was present at that time. Enalapril (Enalapril Maleate 2.5 mg tablets,Wockhardt USA, LLC, Parsippany, NJ 07054 USA) (0.5 mg/kg b.i.d.) and aspirin (C-Aspirin 10 mg/ml, Weise Prescription Shop, Jacksonville FL 32210 USA) (0.6 mg/kg s.i.d.) were started. A follow up exam 7 mo later demonstrated response to treatment (Table 1).

Although the cardiac changes in this case were obvious, normal cardiac values for this species were not available for comparison. A study was conducted to generate echocardiographic data on clinically normal saddle-billed storks for comparison. Five presumptively normal birds were assessed for a total of eight examinations (See Table 2). Examinations were performed under isoflurane (IsoFlo, Abbott Laboratories, North Chicago IL 60064 USA) anesthesia. Blood was collected for hematology, blood chemistry and serum/plasma banking. Electrocardiograms and radiographs were also done. The most common echocardiographic finding was mild mitral regurgitation, requiring no treatment. No other abnormalities were detected.

Additional storks will continue to be assessed to expand the dataset. Future study goals include cardiac exams performed under manual restraint to evaluate the possible effects of anesthesia on the cardiac values. This data will be a valuable contribution to the investigation of cardiac disease in ciconiiformes, an order in which cardiac disease has most recently been documented (D. Whiteside, personal communication).[1,2]

ACKNOWLEDGMENTS

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Table 1. Cardiac ultrasound findings in a 20-yr-old female saddle-billed stork (*Ephippiorhynchus senegalensis*) using a Terason 3000 5 - 8 mhz probe (dorsal and right lateral recumbancy).

	Pre-treatment	Post-treatment
Left atrium diameter (mm)	31.3	28.1
Right atrium diameter (mm)	13.8	12.3
Ejection fraction (%)	45	44
Fractional shortening (%)	22	21
Mitral Regurgitation	> 2 m/s	1.37 m/s
Comments		
Mitral Valve leaflet	Thickened	Persistent thickening
Presence of thrombi	Possible thrombus at IA septum	Small tag thrombus on LA wall
Left atrium size/contractility	Increased/low	Slight improvement

Table 2. Cardiac ultrasound results for five (three male, two female) saddle-billed storks.

Parameter	Range	Mean
RVIDd-EDD[a]	0.81 – 1.13 cm	0.95 cm
RVIDs-ESD[b]	0.74 – 1.5 cm	0.95 cm
IVSd[c]	0.42 – 0.69 cm	0.55 cm
IVSs[d]	0.70 – 0.99 cm	0.81 cm
LVIDd-EDD[e]	1.47 – 2.45 cm	1.90 cm
LVIDs-ESD[f]	1.03 – 1.84 cm	1.53 cm
LVPWd[g]	0.31 – 0.87 cm	0.5 cm
LVPWs[h]	0.70 – 1.02	0.82 cm
EF[i]	61 – 87%	70%
FS[j]	31 – 54%	39%
LAD[k]	1.48 – 2.75 cm	1.87 cm
RAD[l]	1.02 – 2.07 cm	1.35 cm
MR[m]	30 – 39.5 cm/s	34.6 cm/s

[a]RVIDd-EDD = Right ventricular internal dimension (diastolic) – End Diastolic Diameter
[b]RVIDs-ESD = Right ventricular internal dimension (systolic) – End Systolic Diameter
[c]IVSd = Intraventricular Septum diastolic
[d]IVSs = Intraventricular Septum systolic
[e]LVIDd-EDD = Left ventricular internal dimension (diastolic) – End Diastolic Diameter
[f]LVIDs-ESD = Left ventricular internal dimension (systolic) – End Systolic Diameter
[g]LVPWd = Left ventricular Posterior wall (diastolic)
[h]LVPWs = Left ventricular Posterior wall (systolic)
[i]EF = Ejection Fraction
[j]FS = Fractional Shortening
[k]LAD = Left Atrium Diameter
[l]RAD = Right Atrium Diameter
[m]MR = Mitral Regurgitation

HEALTH ASSESSMENT OF CAPTIVE ASIAN ELEPHANTS (*Elephas maximus*) IN INDIA WITH SPECIAL REFERENCE TO TUBERCULOSIS

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Abstract

India has the largest surviving population of Asian elephants (*Elephas maximus*) in the world. Captive Asian elephants in southern India are maintained in different ownership and management regimes. Indices of body, foot, eye and skin as well as wounds and injuries and laboratory test results of clinical samples like whole blood, serum, urine and dung were used to evaluate the health status of each elephant. Seroepidemiology of six major infectious diseases were also analyzed. For tuberculosis diagnosis, the rapid serum test, Elephant TB STAT-PAK® and trunk wash culture were used. Overall seroprevalence of tuberculosis among captive Asian elephants in southern India was nearly 15%. The sub-group with highest interaction with humans namely, the temple elephants showed higher seroprevalence (25%) compared to elephants maintained by private individuals (15%) and State Forest Departments (10%). This study covered captive elephants in the states of Kerala, Karnataka, Tamil Nadu and Andaman and Nicobar Islands. 'Elephant health records' with all results of individual elephants were distributed to the field veterinarians and owners/managers. Population health status gives an indication of the major health problems prevalent in these different groups of elephants and can be a useful tool for suggesting appropriate preventive healthcare.

THE INCIDENCE AND TREATMENT OF RETAINED PLACENTAS IN NON-HUMAN PRIMATE BREEDING COLONIES

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Abstract

Retained placentas were one of the primary reasons for clinical admission in three large non-human primate breeding colonies. Over a 5-yr time span, retained placenta was seen in 4.2% of all cynomolgus macaque (*Macaca fascicularis*) births, 1.1% of all rhesus macaque (*Macaca mulatta*) births, and 5.2% of all baboon (*Papio* sp.) births. Some apparent risk factors for the occurrence of a retained placenta include a stillbirth or prior cesarean section. Of those animals with retained placentas, the association with stillbirths varied, with 72% in cynomolgus, 100% in rhesus, and 47.3% in baboons. Prior cesarean section(s) were not a factor in the two macaque colonies, but were present in 39.1% of baboons with retained placentas. In all colonies, the average age of animals with a retained placenta fell within the prime breeding age range for the species, with both younger and older also being affected.

Treatment of a retained placenta can be challenging in non-human primates due to limited access to the individuals. Successful treatment regimens within the colonies varied greatly. Treatment was tailored to each animal based on their overall health, duration of retention, and history. Treatment modalities ranged from observation to combinations of: manual uterine massage, fluid therapy, pain management, oxytocin injections, antibiotics, vitamin B12 and B-complex injections, iron injections, and curettage and flushing of the uterus. Complications from a retained placenta rarely caused serious long term health problems.

CERULOPLASMIN AND COPPER STATUS IN FREE-RANGING ALASKAN CARIBOU (*Rangifer tarandus tarandus*)

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Abstract

The copper status of caribou (*Rangifer tarandus*) in Alaska was evaluated by liver copper concentration [liver Cu] (*n*=70), serum copper concentration [serum Cu] (*n*=341), and the concentration of ceruloplasmin (*n*=31), a copper carrying protein found in the serum. We compared these results with respect to age class, gender, season, herd, region, and pregnancy status. Age class was defined as: fetus, neonate (≤1mo), calf (>1 mo and ≤ 10 mo), or adult (>10 mo). We categorized two seasons in our analysis: 1) a combination of winter and spring samples, and 2) a combination of summer and fall samples. Two arctic (Western Arctic and Teshekpuk) and two southern herds (Northern Alaska Peninsula and Mulchatna) were pooled to establish the northern and southern regions, respectively. An Analysis of Variance procedure was used to test for differences between covariates, where $\alpha = 0.05$ (SAS, PROC ANOVA). No serum samples from neonates or pregnant females, or liver samples from calves, were available so we were unable to test for differences within all categories of each variable. Age class was significant for both [serum Cu] ($p = 0.0001$) and [liver Cu] ($p = 0.0001$). [Serum Cu] from neonates (mean = 0.959, SE = 0.145) were significantly greater than calves (mean = 0.580, SE = 0.036) and adults (mean =0.544, SE = 0.01). [Liver Cu] from fetuses (mean = 224.2, SE = 78.6) and neonates (mean = 123.7, SE = 12.3) were significantly greater than adults (mean = 16.9, SE = 12.4). This was not unexpected since in domestic ungulates, fetal and neonatal liver storage is high to meet the Cu requirements prior to weaning. Herd was significant for [serum Cu] ($p = 0.0001$). [Serum Cu] from Western Arctic (mean = 0.692, SE= 0.031) were significantly greater than other herds. [Serum Cu] from Teshekpuk (mean= 0.576, SE = 0.018) were significantly greater than Northern Alaska Peninsula (mean = 0.515, SE = 0.013). Seasonal differences of [serum Cu] within a herd were only significant within the Northern Alaska Peninsula herd ($p < 0.0001$). [Serum Cu] winter/spring (mean = 0.445, SE = 0.014) was significantly less than summer/fall (mean = 0.578, SE = 0.018). This is consistent with this herd's poor health status and heavy parasite loads. These results lead to additional studies to elucidate the significance of the nutritional – parasite interaction on caribou herd health. A significant difference was found between genders for [serum Cu], particularly during the summer/fall season ($p = 0.0014$). [Serum Cu] for males (mean = 0.648, SE = 0.016) were significantly greater than females (mean = 0.577, SE = 0.041). While region wasn't statistically significant, the northern herds had a lower mean [liver Cu] (mean = 47.4, SE = 13.3) than the southern herds (mean = 64.9, SE= 10.9), despite all the high fetal liver copper included in the northern herds. Non-pregnant adults (mean = 18.4, SE = 2.0) and pregnant female (mean = 8.2, SE = 1.7) were significantly different for [liver Cu] ($p < 0.021$). Our observation of high fetal [liver Cu] and low pregnant female

[liver Cu] supports the conclusion that there is mobilization of copper stores from the cow to the fetus. In addition to these analyses, we also examined the correlations between [serum Cu], ceruloplasmin, and [liver Cu] (SAS, PROC CORR, Pearson). No correlation was detected among any combination of copper measurement, likely limited by the small sample size. Thus, until additional paired serum and liver samples can be evaluated, neither ceruloplasmin or [serum Cu] can be substituted as a direct measure of copper status in live-captured caribou. We were limited by opportunistic sampling but in the future, evaluation of more representative samples with respect to age class, gender, season, and herd, will allow us to better evaluate the variation in copper status and its implications for herd health in caribou.

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POST-MORTEM FINDINGS IN PERFORATING GASTRIC ULCERS OF TWO ATLANTIC BOTTLENOSE DOLPHINS (*Tursiops truncatus*)

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Abstract

Gastric ulceration and associated clinical syndromes are identified as causes of morbidity and mortality in captive and wild cetaceans.[1,2] Proposed etiologies include parasitic infection, bacterial colonization, and high levels of gastric histamine.[3-5] The impact of gastric ulceration ranges from seemingly benign incidental findings to fatal perforation. While gastric ulceration is associated with morbidity in cetaceans, there are limited reviews of clinical presentations, diagnoses, and outcomes and few reports of secondary abscess formation.

Two cases of gastric abscess secondary to gastric perforation in captive Atlantic bottlenose dolphins (*Tursiops truncatus*) were definitively diagnosed at necropsy. These individuals had a 3-mo (Case 1) and 2-yr (Case 2) history of illness. Major clinical signs included reduced feed intake and lethargy. Treatment during management included antibiotics, gastroprotectants, sedatives, and supplemental nutrition. Review of clinical pathology data showed that markers of inflammation such as white blood cell count, erythrocyte sedimentation rate, fibrinogen, and protein electrophoresis were relatively non-specific and often normal during clinical illness. In Case 1, major gross necropsy and histopathology findings included an abdominal abscess adjacent to the liver and stomach, erosions with bacterial colonization in the gastric mucosa, peritonitis, and acute multi-organ inflammation and necrosis. In Case 2, major gross necropsy and histopathology findings included a perigastric abscess approximately the size of the stomach complex with multiple smaller abscesses in the stomach wall and pancreas, peritonitis, and a stellate scar in the third gastric chamber considered consistent with a fully healed ulceration. There was no evidence of active ulceration at the time of necropsy. A definitive etiology for ulceration in both cases was not determined.

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SEMEN CRYOPRESERVATION AND TRANSCERVICAL INSEMINATION IN THE MEXICAN GRAY WOLF (*Canis lupus baileyi*)

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Abstract

Successful captive breeding is essential to recovery of Mexican gray wolves (*Canis lupus baileyi*). The long-term monogamous mating system of wolves, the fact that not all SSP-assigned pairs reproduce, agency restrictions on human contact, and prohibition of surgical insemination present challenges for captive reproduction. Our objectives were to improve sperm longevity and develop transcervical insemination (TCI) using generic grey wolves and domestic dogs as models. Longevity of sperm (collected by electro-ejaculation) was not significantly different over 24 hr between generic gray wolves and domestic dogs, but semen collected from dogs by manual stimulation had prolonged motility ($P < 0.05$), suggesting increased exposure to prostatic fluid in electro-ejaculated samples may affect longevity. Semen from six generic gray wolves was extended in three commercial semen extenders (CaniPro™ Chill 5, Minitube of America, Verona, WI 53593; Fresh Express®, Synbiotics, Kansas City, MO 64163; Kenney Formula, Reproduction Resources, Walworth, WI 53184) or a traditional Tris-based extender. At 24 hr, progressive sperm motility was highest ($P < 0.05$) in Fresh Express® and CaniPro™ Chill 5 extenders. In a different experiment, semen samples collected from six generic gray wolves via electroejaculation were either immediately centrifuged and then suspended in semen extender (traditional protocol), or immediately diluted in semen extender and then centrifuged to reduce exposure to prostatic fluid. There was no significant difference between the two methods. When semen was manually collected from two generic gray wolves and placed in these extenders, progressive motility (assessed over 24 hr) appeared better in Fresh Express ®. Furthermore, to maximize fertility with frozen-thawed semen, endoscopic TCI, used routinely in domestic dogs, is being developed for the Mexican gray wolf.

STRESS LEVELS DURING CHEMICAL VS. MANUAL RESTRAINT IN WOOD BISON (*Bison bison athabascae*) AS INDICATED BY BLOOD LACTATE AND GLUCOSE

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Abstract

Blood lactate (mmol/L) and glucose (mg/dL) concentrations were measured in captive wood bison (*Bison bison athabascae*) restrained for disease testing and health, pending reintroduction into Alaska. The majority of the herd (n = 70) were restrained in a hydraulic squeeze chute, though the larger, more aggressive animals (n = 9) were chemically immobilized via darting using a combination of thiafentanil and xylazine. A General Linear Model was used to test for differences in blood [lactate] and [glucose] among eight categorical and three continuous variables related to demographics, restraint technique, handling times, and factors assumed to cause additive stress, where $\alpha = 0.05$ (SAS, PROC GLM). Additive stressors were documented during the handling and include things such as the use of an electric prod, an injury occurring during handling, and observed aggressive conspecific interactions. We also tested for a correlation between [lactate] and [glucose] (SAS, PROC CORR, Pearson).

Consistent with our expectations, a highly significant difference ($p < 0.0001$) was found in [lactate] among the three categories of restraint techniques; this relationship was not demonstrated for [glucose]. Darted animals exhibited the lowest [lactate] ($\bar{x} = 0.9$, SE = 0.15), while animals handled through the chute system had the highest [lactate] ($\bar{x} = 11.7$, SE = 0.53) and bison unsuccessfully moved through the chute system and subsequently darted fell in between ($\bar{x} = 4.2$, SE = 0.90). No correlation was observed between [lactate] and [glucose] ($R = 0.075$). For chute-handled bison, no significant differences were found for [lactate] or [glucose] with respect to the day of handling, gender, age, order through the chutes, or additive stressors. Animals with shorter handling times were shown to have significantly higher [lactate] ($p = 0.0347$). Restraint time, (the amount of time in the hydraulic squeeze), did not affect [lactate]. However, animals with shorter restraint times did have significantly higher [glucose] ($p = 0.0293$), such that each minute increase in handling time resulted in a ~1% decrease in the median [glucose]. The total handling time did not have a significant affect on [glucose]. While we expected that chemical restraint would be less stressful to the bison than other techniques, we did not anticipate that shorter handling times would yield higher [lactate]. We propose that wood bison, as herd animals, likely recover quickly from individual stressful events. However, swift processing through a chute system does not allow time for this lactate recovery, as there is little to no rest period between segments of the chute system. In brief handlings (<18 min), the point in time where we collected our blood sample allowed us to actually measure cumulative stress, whereas in the longer handlings (>38 min) our blood sample was more representative of an acute response to the most recent stressor(s).

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FENTANYL TRANSDERMAL THERAPEUTIC SYSTEM PHARMACOKINETICS IN BALL PYTHONS (*Python regius*)

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Abstract

Despite a nominal understanding of reptile analgesia, it has been shown that morphine, a μ-opioid receptor agonist, desensitizes the response to noxious stimuli in various reptilian species.[2,3,5] Fentanyl, a μ-opioid agonist with 75-100 times the potency of morphine, is formulated for use as a Transdermal Therapeutic System (TTS) and has recently been shown to absorb across the skin of prehensile-tailed skinks (*Corucia zebrata*).[1] Snakes, which possess highly permeable skin, appear to be ideal candidates for effective transdermal analgesia.[4]

Fentanyl TTS (12 μg/hr, Mylan Pharmaceuticals Inc, Morgantown, WV 26505) were applied to the cranial one-third dorsum of five ball pythons, (*Python regius*), using the adhesive backing and staples. Specimens ranged in body weight from 1.26-1.99 kg. Cardiac blood samples were drawn for nine days and plasma fentanyl concentrations determined at times T = 0, 4, 8, 12, 24, 36, 48, 60, 72, 96, 120, 144, and 216 hr using HPLC-Mass Spectroscopy. Measurable concentrations were achieved within 4 hr. Minimum therapeutic concentrations, as defined in mammals as 1 ηg/ml, were reached within 8 hr and sustained throughout the study. The mean and maximum concentrations were substantially higher than those hypothesized to attain analgesia in mammals, suggesting the potential to utilize smaller dosages. Snakes exhibited less activity but, no adverse side effects were observed. All patches remained securely attached throughout the study. This study concludes the TTS system delivers quantifiable fentanyl levels in ball python plasma, and could potentially serve as an alternative route for prolonged analgesia administration to snakes.

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INVESTIGATION OF WILD AND FERAL CARNIVORES AS RESERVOIRS OF ALEUTIAN DISEASE VIRUS

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Abstract

Aleutian disease (AD) is a parvovirus of ranched mink that is associated with poor kit production and adult mortality. All color phases of ranched mink are susceptible, but the light colors derived from the Aleutian color phase are most prone to morbidity and mortality. Ranched mink can be tested for AD and an eradication program implemented. Wild carnivores are thought to be a potential reservoir for AD in ranched mink. Wild and feral carnivores including feral cats (n=19), skunks (n=5), mink (n=13) and raccoons (n=2) were live trapped, euthanatized and sampled. Blood and tissue samples were collected and submitted for testing for AD and related viruses. Serum samples were tested for AD using the counter electrophoresis test (CEP) and the lateral flow test, and for Canine parvovirus and Feline Panleukopenia using indirect fluorescent antibody assays. One feral cat, 4 skunks, and 7 mink were positive for AD on the CEP. All animals except one mink were negative for AD on the lateral flow test. A total of 15/19 and14/15 feral cats and 1/2 raccoons were positive for canine parvovirus and feline panleukopenia, respectively, but none of the mink or skunks were positive for exposure to either virus. The tests could not easily distinguish between the three pathogens. Fecal samples were tested for the presence of AD virus using PCR, but all samples were negative. Liver and kidney samples were tested for the presence of AD by IHC, but all tissues from all animals were negative. The cause of the serologic reactions in the feral cats is likely due to exposure to feline panleukopenia virus which appears to have cross reactions with the CEP and LF test in this species. The cause of the positive CEP and LF in the mink is unknown as no evidence of AD virus was found in any of the mink. It appears that feral cats and wild skunks, raccoons and mink do not appear to be important as reservoirs of AD for ranched mink in Idaho.

CAPTURE AND ANESTHESIA OF FREE-RANGING BROWN BEARS (*Ursus arctos*) DURING HIBERNATION

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Abstract

We immobilized seven hibernating sub-adult (2- to 3-yr-old) brown bears (*Ursus arctos*) in central Sweden in February 2010 as part of comparative physiologic research. Bears were located with VHF radio tracking. Snow over the den entrance was uncovered with a shovel. Five bears were darted through a metal grate placed over the den entrance. Two bears in rock dens found alternate escape routes and were darted outside the den. For anesthesia, medetomidine (Domitor®) at 0.02-0.06 mg/kg and zolazepam-tiletamine (Zoletil®) at 1.2-2.8 mg/kg were used. In four bears, ketamine (Narketan®) at 1.5 mg/kg was added to the dart or hand-injected before handling. Bears weighed 45-54 kg. Once anesthetized, bears were removed from the dens for monitoring and sample collection. In four bears, arterial blood samples were tested with an iSTAT®1 Analyzer (CG4+ & EC8+, Abbot Laboratories, Abbot Park, Illinois, USA). The bears were placed back in the dens, covered with branches, and reversed with atipamezole (Antisedan®) at 5 mg per kg of medetomidine. The branches were covered with snow and the bears were left to recover undisturbed.

The drugs and doses provided adequate anesthesia for the procedures performed. Physiologic variables during anesthesia are presented in Table 1. Oxygen supplementation (2L/min) provided to one bear markedly increased arterial oxygenation. Hypoxemia was recorded in two of four bears (PaO_2 43-67 mmHg). All bears survived and emerged from the dens during April 2010. This is the first report of capture and anesthesia in free-ranging brown bears during hibernation.

Table 1. Physiologic variables during anesthesia of hibernating brown bears. Partial pressure of arterial oxygen (PaO_2) and pH were corrected to the rectal temperature.

Time from darting	**15-35 min**			**65-75 min**		
	Mean	Range	N	Mean	Range	N
Heart rate (beats/min)	35	23-50	6	25	16-30	4
Respiratory rate (breaths/min)	9	4-16	7	7	3-12	4
Temp (ºC)	33.3	32.2-34.8	7	33.6	32.2-36.6	5
Lactate (mmol/L)	2.3	1.5-3.2	4	1.4	1.2-1.5	3
	Individual values			Individual values		
PaO_2 (mmHg)	57, 67, 106		3	43, 100		2
SaO_2%[a]	91, 93, 93, 98		4	82, 97, 100		3
pH	7.23, 7.25, 7.25		3	7.23, 7.24		2

[a]SaO_2 = arterial oxygen saturation calculated by the i-STAT®1.

DISSEMINATED MYCOBACTERIOSIS IN A HEAD START COLONY OF HOUSTON TOADS (*Bufo houstonensis*)

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Abstract

The Houston toad (*Bufo houstonensis*) was the first amphibian granted protection under the U.S. Endangered Species Act. Since 2007, the Houston Zoo has participated in a "head start" program, where high-mortality life stages (such as larval and juvenile stages) are protected and released after they have reached a certain size. In 2009, 6 tadpoles and 60 toads from a group of 3000 individuals developed disseminated granulomatous disease with acid-fast bacteria present. Visible lesions were in the form of raised skin masses or of "melting" skin ulcers, and were microscopically diagnosed as pyogranulomatous dermatitis with intra-lesional acid-fast bacteria. Affected toads also had internal pyogranulomatous inflammation with intra-lesional acid-fast bacteria in the liver, kidney, or intestines, or less commonly in the spinal column, eye, and brain. Many affected Houston toads had internal lesions without visible skin lesions, making pre-mortem diagnosis of this condition challenging. *Mycobacterium chelonae* was identified through culture and molecular assay, and was determined to be sensitive to ciprofloxacin. Surviving adults have undergone treatment with enrofloxacin, random disease screening, and isolation from other head start toad groups. Clinical lesions associated with mycobacterial infection have sporadically been reported in adult anurans, but additional work is required to elucidate epidemiology and develop treatment options. This is the first reported observation of mycobacterial lesions in tadpoles.

GENERAL BIOSECURITY GUIDELINES FOR ZOOS

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Abstract

This purpose of this poster is to provide an approach to biosecurity in a zoo for preventing and managing infectious diseases that could threaten the health of the animal collections, employees, guests, and others on or using the zoo facilities. According to the U.S. Department of Agriculture, the word "biosecurity" is defined as those precautions taken to minimize the risk of introducing an infectious disease into an animal population.[8] We use the term to refer to all programs of infection control within a zoo facility. Several publications are available to help in formulating general biosecurity measures in zoos.[1-7]

These general guidelines can be used by veterinarians in zoos to set up procedures for staff, volunteers, and contractors that work with and around animals in zoo facilities. Biosecurity procedures for specific diseases or circumstances can be addressed separately (e.g., Primate safety guidelines, bat handling guidelines, reptile handling guidelines, highly pathogenic avian influenza, and exotic Newcastle disease,[6] etc.).

Categories of biosecurity measures can include those for facilities, animal care staff, collection animals, animal feed, wild and feral animals, routine disease surveillance, biosecurity communications and education, employee preventive and occupational health care, and enhanced biosecurity and control measures in the event of a foreign animal disease in the region.

A group of senior zoo staff can be assigned to address infectious disease and zoonosis threats. The group can draft, approve, and periodically review biosecurity guidelines and convene as needed to address specific infectious disease situations.

ACKNOWLEDGMENTS

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USE OF A SYBR GREEN REAL-TIME POLYMERASE CHAIN REACTION AND MELT ANALYSIS TO DETECT *Mycoplasma* SPECIES IN LYMPH NODES FROM ELK (*Cervus elaphus*)

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Abstract

Mycoplasmas have been identified as disease agents for humans, livestock and wildlife, and mycoplasmas have caused large population declines in some animals. Detecting mycoplasmas in wildlife and identifying them as the cause of disease syndromes is complicated by the culture requirements of many mycoplasmas and the difficulty of obtaining fresh specimens from free-ranging animals.[1] A real-time PCR method utilizing SYBR dye has been developed for the detection of *Mycoplasma* spp. in several different types of biological samples.[2] With it, several species of mycoplasma can be differentiated on the basis of the melt temperature, and the length and sequence of the PCR amplicon. Twenty-nine elk lymph nodes collected in 2008 by Utah Department of Wildlife Resources during annual Chronic Wasting Disease surveillance were selected for testing. Mycoplasmas were detected in 4 of the lymph node samples. The PCR products were further analyzed with standard gel electrophoresis followed by extraction of the DNA and sequencing. The length of the amplicon was estimated to be 235 bp with a capillary electrophoresis platform (2100 Bioanalyzer, Agilent). The sequences of 2 samples were homologous and further analyzed for similarity to known bacterial sequences with BLAST (http://blast.ncbi.nlm.nih.gov/Blast.cgi). The sequences were most similar to *M. ovipneumoniae* (96%), *M. hyopneumoniae* (93%), and *M. dispar* (93%). The biological relevance of the identification of a *Mycoplasma* spp. in elk is unknown. Outbreaks of mycoplasmal respiratory disease have not been reported in elk. The results suggest that additional research into the occurrence of mycoplasmas in elk as well as other wildlife species is warranted.

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CERVICAL SALTER I PHYSEAL FRACTURE IN A BARINGO GIRAFFE (*Giraffa camelopardalis*)

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Abstract

A 5-yr-old female Baringo giraffe (*Giraffa camelopardalis*) sustained a cervical injury during transport from another facility as part of a breeding transfer. Medical management with analgesics, anti-inflammatories, vitamin E, and muscle relaxants was attempted but the apparent severity of the injury increased over time. The animal was immobilized and radiographs were taken of the affected area and revealed a cranial cervical vertebral Salter I physeal fracture with the cranial articulated vertebrae residing at a 90 degree angle. The animal died during recovery and necropsy dissection of the cervical spine confirmed a fractured C5 vertebrae. The cranial vertebral "cap" had fractured off at the physis and rotated to its final position. Surrounding tissues were severely affected and the spinal cord followed the vertebral bodies mal-alignment by coursing over the injury at a 90 degree angle. The animal showed no neurologic deficits suggestive of cervical spinal impingement. Tissues were submitted for histopathology to the Oklahoma Animal Disease Diagnostic Laboratory (Oklahoma State University, Stillwater, OK 74076) and showed extradural fibrosis of the spinal cord and severe, chronic fibrosis of the skeletal muscle surrounding the affected vertebrae. The injury sustained was inoperable and the clinical impression is that neurologic deficits were the most likely sequelae.

Taenia cysticerci IN A CAPTIVE-BORN EMPEROR TAMARIN (*Saguinus imperator*)

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Abstract

A captive-born 13-yr-old female emperor tamarin was presented for abdominal swelling. Abdominal ultrasound demonstrated a cystic mass adjacent to the liver. Abdominal exploratory revealed hundreds of cystic structures engulfing the entire gastrointestinal tract, attached to the parietal peritoneum, and free floating in the abdomen. Histopathology confirmed cestode larval cysts. The cysts are *Taenia cysticerci*. The proposed life cycle is discussed.

ACKNOWLEDGMENTS

The authors would like to thank the zookeepers of the Santa Ana Zoo for their assistance in their care of this animal.

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ENDOCRINE FUNCTION IN AMERICAN BLACK BEARS (*Ursus americanus*)

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Abstract

Obesity is one of the most common health problems of captive American black bears (*Ursus americanus*). In addition to not being able to provide a truly natural diet or the quantity of physical activity wild bears experience, many zoos do not allow their bears to hibernate over winter. Studies examining wild, or recently captured, black bears show reduced thyroid hormone levels during hibernation but comprehensive examination of thyroid hormones or glucose metabolism in captive and wild bears have not been reported.[1-3]

Wild (n = 4 - 5), captive hibernating (n = 5), and captive non-hibernating (n = 5) bears were evaluated at times corresponding to their three major physiologic stages: fall (Hyperphagic stage), winter (Hibernation stage), and summer (Normal Activity stage). The same bears were not evaluated at each stage. Blood samples were analyzed for T4, T3, free T4, and free T3 concentrations and a combined insulin and glucose tolerance test was performed (a loading dose of 0.5 g/kg dextrose i.v. and serial blood samples obtained at pre- & 15, 30, 45 & 60 min post-glucose administration; 0.03 IU/kg Humulin R insulin was administered immediately after the 15 min sample was obtained; each sample was analyzed for insulin and glucose concentrations). The glucose curves were similar for all bears within a given stage. All three groups of bears had evidence of insulin resistance during the winter as compared to the summer on glucose curves. Analysis of thyroid hormone concentration varied and distinct patterns or similarities were not apparent.

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SPERMATIC PROFILE OF CAPTIVE GIANT ANTEATER (*Myrmecophaga tridactyla* Linnaeus, 1758)

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Abstract

Semen analysis is the first step towards the use of Assisted Reproductive Techniques (i.e. artificial insemination, embryo transfer) as tools for conservation of endangered species. The aim of this study was to analyse semen samples from captive Giant Anteaters (*Myrmecophaga tridactyla*). Animals were anesthetized with 7.0 mg/kg of Ketamine (Ketalar® injectable suspension 5%, Pfizer do Brasil, Guarulhos, SP 07190-001, Brazil) and 0.6 mg/kg of Midazolam (Dormonid® injectable suspension 10%, Roche do Brasil, Rio de Janeiro 22710-104, Brazil) i.m. Semen samples were collected through electroejaculation using a bipolar rectal probe connected to a commercially available electroejaculator (AC-60Hz). The regimen of electrical stimuli were composed by series of 10 stimuli in each voltage, beginning with 2 V and increasing until 6 V. Semen was assessed by a routine descriptive analysis designed to determine volume, concentration, vigor, motility, major, minor and total defects. Acrossome and cell membrane integrity were assessed through Pope´s simple staining and eosine/nigrosine methods, respectively. Chromatin fragmentation was determined in a flow citomether and mitochondrial activity was measured by a test based on the oxidation of 3,3'-diaminobenzidine (DAB). Results are presented in Table 1.

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Table 1. Results of the spermatic profile from giant anteater (*Myrmecophaga tridactyla*).

	Mean	SEM
Volume (µl)	1279	± 271
Concentration (x 10^6 /ml)	129.415	± 36.136
Vigor (0 - 5)	2.3	± 0.2
Motility (%)	33	± 6
Major Defects (%)	54	± 6
Minor Defects (%)	11	± 2
Total Defects (%)	64	± 6
Acrossome Integrity (%)	84	± 31
Cell Membrane Integrity (%)	81	± 4
Chromatine Fragmentation (%)	13.2	± 3.7
Mitochondrial Activity Class I (%)	66	± 6
Mitochondrial Activity Class II (%)	19	± 3
Mitochondrial Activity Class III (%)	8	± 2
Mitochondrial Activity Class IV (%)	4	± 1
Mitochondrial Activity Class V (%)	3	± 1

DYSTOCIA AND CESAREAN SECTION IN A MULTIPAROUS PRZEWALSKI'S HORSE (*Equus ferus przewalskii*) MARE

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Abstract

Dystocia in the horse is defined as stage 2 labor exceeding 30 min.[1] A 20-yr-old Przewalski's horse mare was discovered in stage 2 labor. Fetal membranes protruded through the vulva, and over the ensuing 2 hr, the mare remained quiet but labor did not progress. Immobilization was necessary for reproductive examination, and the mare was anesthetized with detomidine (Pfizer Animal Health, Exton, PA 19341 USA; 0.26 mg/kg i.m.) and carfentanil (Wildife Pharmaceuticals, Fort Collins, CO 80522 USA; 21 µg/kg i.m.).

Vaginal examination revealed an open cervix with the fetus in anterior presentation, dorsopubic position, and ventroflexion of the head and flexure of all limbs. Despite repeated attempts, the fetus could not be delivered. No signs of life were encountered in the foal. Cesarean section was elected over fetotomy. A right paralumbar surgical approach was made and a routine hysterectomy was performed. A dead but grossly normal, fully-developed fetus and normal placenta were extracted. Oxytocin (Bimeda-MTC Animal Health, Cambridge, Canada; 0.06 U/kg i.v.) and anesthetic antagonists were administered post-operatively. Post-mortem exam concluded this was a uterine body pregnancy. There has been at least one other live foal resulting from a uterine body pregnancy in this collection, though not from this mare.

The mare remained hospitalized for 6 wk. Perphenazine (Kryon Laboratories, Benrose, South Africa; 0.5 mg/kg i.m.) was used to keep the animal calm. Moderate incision swelling and ventral edema were the only significant post-operative complications. This is the first report of dystocia and Cesarean section in a Przewalski's horse.

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The authors thank the Department of Mammalogy and the Wildlife Health Center staff, who generously invested their time and shared their expertise in caring for this special animal and helping to achieve a successful outcome.

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AVIAN INFLUENZA: NEW TRAINING MATERIALS FOR ZOOS

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Abstract

As part of a Cooperative Agreement with United States Department of Agriculture Animal Care, the Zoo Animal Health Network (ZAHN) has developed a web based and DVD training tool that explores influenzas in non-domestic species. While a number of excellent on-line training programs exist about Avian Influenza, most address the disease in poultry. Our on-line learning tool has been tailored to the specific needs of the zoologic niche.

Our approach was unique. ZAHN assembled subject matter experts for a 2 day workshop, representing USDA Animal Care, Association of Zoos and Aquariums, AAZV veterinarians, academic experts and others. This collaborative approach to content development was critically important to address the various needs of the exotic animal community. Our audience is any exhibitor licensed by USDA, which includes zoos and other animal enterprises. The baseline knowledge about these viruses varies tremendously across our target audience, so our product had to address basic learning objectives, and provide more in-depth subject matter for animal care managers.

Our product is unique. The course content reviews viral basics, epidemiology, and outbreak management, but we have also included basic exercises to involve the learner in decision-making scenarios. A combination of narration, animation, and photography is designed to engage the learner as well, and to increase the likelihood of knowledge transfer after completing the course.

FELINE INFECTIOUS PERITONITIS IN CHEETAHS (*Acinonyx jubatus*) IN DUBAI, UAE

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Abstract

During 2009-2010 cheetahs (*Acinonyx jubatus*) in two collections (sites 1 and 2) in Dubai (UAE) showed clinical signs consistent with Feline Infectious Peritonitis (FIP).[1] A total of fourteen animals presented with diarrhea, lethargy, anorexia, weight loss, abdominal distention and/or regurgitation. Clinical examination and sample collection were performed under general anesthetic (intramuscular 2.5mg/kg ketamine (Keta-inject 10%, Dopharma, Raamsdonkveer, NL) plus 0.07mg/kg medetomidine hydrochloride (Domitor, 1mg/ml, Orion Pharma, Newbury, UK) reversed with 0.35mg/kg atipamezole (Antisedan, 5mg/ml, Orion Pharma, Newbury, UK). Diagnosis of FIP was also supported by electrophoresis (EP), hematology and biochemistry findings such as anemia (46%), hyperproteinemia (69%), hypoalbuminemia (54%) often combined with hyperglobulinemia (54%) causing a decreased albumin-globulin ratio (38%), pronounced leucocytosis (69%) with neutrophilia (38%) and lymphopenia (54%).[2] Unfortunately no records were made of animals with transient diarrhea so a morbidity estimation cannot be made. However mortality after only 1 yr was 32% and 50% in sites 1 and 2 respectively. The majority of deaths occurred amongst young cheetahs (75% < 3 yr) and male cheetahs, with 43% and 75% of the total male population succumbing to the infection in sites 1 and 2 respectively. Compared to this the female death toll was significantly lower with 18% in site 1 and 33% in site 2. Post mortem findings confirmed FIP in 77% of the animals that died during this 12-mo period. Sequential testing of surviving cheetahs was done using rapid FIP snap tests, coronavirus immunocomplex, EP, and the results will hopefully contribute to the FIP diagnostic puzzle.

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FELINE LEUKEMIA VIRUS IN A BLACK-FOOTED CAT (*Felis nigripes*)

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Abstract

Feline leukemia virus (FeLV) is an RNA retrovirus, which can insert into its host's genome allowing persistent infection. This report documents suspected diminished immunocompetence due to FeLV infection and concurrent infection with multiple common feline pathogens in a captive-bred juvenile black-footed cat. Using a feline upper respiratory pathogen PCR panel, presence of feline calicivirus was confirmed with observation of systemic signs of the disease. Incidental detection of *Mycoplasma felis* and *Bordetella bronchiseptica* was performed using the same panel. In addition, this individual had clinical signs of pancreatic insufficiency and gastritis/enteritis. The gastritis of multiple inflammatory cell types was identified histologically both antemortem and post-mortem, along with presence of gastric *Helicobacter* spp. A chronic hematuria of unknown etiology also was observed until time of euthanasia. Although presence of FeLV was confirmed on serum ELISA and bone marrow IFA, no gross or histopathologic lesions attributable to FeLV infection were found upon necropsy. To the author's knowledge, this is the first report of FeLV infection in this species. The outcome of this case stresses the importance of pest control and rigid preventive medicine and quarantine practices in zoos.

TREATMENT AND WOUND MANAGEMENT OF A SEMI-CAPTIVE HARPOONED MANATEE (*Trichechus manatus*) IN LAGUNA GUERRERO, MEXICO

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Abstract

In Mexico, causes of death of manatees related to human activities include watercraft collisions, gun-shots, fishing nets, hunting and harpoons.[2] A 6-yr-old manatee (*Trichechus manatus*) living in semicaptivity in Laguna Guerrero, Mexico was injured by a home-made harpoon in the dorsum. The deep wound was located to the right of the dorsal midline at the level of 7th and 8th thoracic vertebra, and was approximately 20 cm of diameter. A 5-cm length of the harpoon was still inside the wound at the time of presentation, and there was severe tissue damage and bleeding. A 2 cm-incision was made for the extraction of the harpoon, and a topical treatment chlorhexidine and iodine were instilled into the wound. Local antibiotic therapy and methyl methacrylate beads of Gentamicin were applied. Topical application of honey was used while the wound was open to enhance health and eliminate bacteria.[1] Hematology and blood chemistry were within normal values; *Aeromonas hydrophila* and *Staphylococcus* sp. were isolated from the wound. Severe inflammation was still present 114 days after the incident, and a small irregular mass of whitish tissue protruded from the wound. Histopathology from the mass revealed fibrosis with foci of keratin and fibrin with few intralesional mixed bacterial colonies. The remaining tissue was removed during the next 2 days, and the wound was completely healed 87 days later. This is the first report of a harpooned manatee recovering from a harpoon injury in Quintana Roo, México.

ACKNOWLEDGMENTS

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HEMATOLOGY, PARASITES, ORAL AND CLOACAL FLORA OF WILD AMERICAN CROCODILES (*Crocodylus acutus*) FROM COZUMEL ISLAND, MEXICO

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Abstract

This study was carried out at Colombia lagoon, Chinchaka'ab lagoon and Xtakún lagoon in the Ecological Reserve of Punta Sur in Cozumel Island, Mexico. A total of 35 wild American crocodiles (*Crocodylus acutus*) were captured and sampled. Values of hematocrit, red blood count, white blood count, heterophils, lymphocytes, monocytes, neutrophils, eosinophils, basophils and azurophils were determined from blood samples of 18 individuals. Mean normal values and ranges of these parameters are close to those reported for the species in captivity. Blood eosinophilia was detected in 16 (88.9%) individuals and could be due to the presence of *Hepatozoon* spp., a hemoparasite identified in 15 (42.9%) of the 35 crocodiles. Cloacal and oral cavity swabs were collected from 33 specimens of different size/age classes: Eight yearlings, 18 juveniles, three sub-adults and four adults. We isolated and identified 19 bacteria from oral cavities and 14 from cloacal cavities. The more frequent bacteria isolated from oral samples were *Archanobacterium pyogenes*, *Aeromonas hydrophila*, *Streptococcus agalactiae* and *Moraxella cuniculi*, and the more frequent from cloacal samples were *Escherichia coli*, *Aeromonas hydrophila* and *Salmonella arizonae*. This study is the first report of cloacal flora of wild American crocodiles and the second report for oral flora.[1] All crocodiles captured in this study showed no clinical signs of disease, but under certain circumstances some of the bacteria isolated could be pathogenic. Several oral bacteria isolated could also cause septicemia in human after being bitten by a crocodile.

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The authors would like to thank Fundación de Parques y Museos de Cozumel for their hospitality and support in this study.

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DETECTION AND CHARACTERIZATION OF A NOVEL HERPESVIRUS FROM THE TRACHEA OF TWO COMMON LOONS (*Gavia immer*)

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Abstract

Avian herpesviruses associated with respiratory disease include Infectious Larygotracheitis Virus of chicken (Ga-HV1),[1] Amazon tracheitis virus (not sequence characterized),[2] and Passerid Herpesvirus-1 in Gouldian finches.[3] The common loon (*Gavia immer*), a migratory fish-eating Gaviiform, is an important indicator of aquatic ecosystem health.[4-6] Two wild adult common loons were evaluated after being found stranded in mainland North-Central Florida at separate occasions. On the basis of upper airway endoscopic and cytologic findings, severe ulcerative tracheitis was diagnosed antemortem in one of the birds, while more subtle lesions were observed in the other. A novel herpesvirus was detected antemortem in both birds from tracheal samples using nested consensus PCR amplification of the polymerase gene and sequencing. Despite prolonged intensive medical care, the bird with severe lesions failed to improve and was euthanatized 9 days after endoscopy. No viral inclusions were evident histologically in the lesions. However, an undulating tracheal mucosa in a "mountain ridge" pattern, resulting from epithelial regeneration and hyperplasia, was present, as is seen in the late stages of infectious laryngotracheitis in chickens.[1] The second bird recovered and was subsequently released. The genetic distance seen between this and other characterized herpesviruses supports placement of this virus as a novel species, referred to as Gaviid herpesvirus 1 (GavHV1). The phylogenetic analysis showed that GavHV1 clusters within the genus *Iltovirus*. The relationship between the observed lesions and the virus remains to be demonstrated. Further studies are indicated to investigate the role of this virus in morbidity and mortality of free-ranging and captive loons.

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HEPATOZOON IN AN EMERALD TREE BOA (*Corallus caninus*)

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Abstract

The emerald tree boa (*Corallus caninus*) is a non-venomous, strictly nocturnal and arboreal species, found in the rainforests of South America. It spends its days in a characteristic coil over a tree branch with its head perched at the center. They are a popular snake although reported to be moderately difficult to maintain.

The genus Hepatozoon is comprised of a large assemblage of apicomplexan blood parasites.[1] The general life cycle involves ingestion of the insect vector (mosquitoes) and experimentally via infected rodents, release of the sporozoite and circulation to various organs.[2] Generally once they enter the liver, the sporozoite form schizonts within the parenchymal cells. Several rounds of merozoites released from mature schizonts reenter hepatocytes until the final generation which produces merozoites that enter mononuclear leukocytes. Infections are generally considered incidental in the natural host.[1,3]

Two emerald tree boas were rescued from improper care. The husbandry was improved; however, the male remained underweight. He developed diarrhea that progressed to open-mouth breathing before dying. On histology large numbers of protozoal meronts were identified in the pulmonary interstitium and associated with a granulomatous nephritis. The results of this case suggests that hepatozoon is capable of inducing inflammatory lesions in some reptilian hosts. Stress from improper husbandry, poor body condition, or concurrent diseases may result in more significant lesions.

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EVALUATION OF MS-222 CONCENTRATIONS ON KOI (*Cyprinus carpio*) VITAL FUNCTIONS, BIOCHEMICAL VALUES AND RESPONSE TO NOXIOUS STIMULATION AT TWO ANATOMIC SITES

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Abstract

The objective of this study was to evaluate the physiologic and analgesic effect of five concentrations of MS-222 (Tricane-S, Western Chemicals, Inc, Ferndale WA 98248, USA) on 21 healthy adult Koi (*Cyprinus carpio*). Each fish was exposed to five concentrations of MS-222 (50 ppm, 70 ppm, 110 ppm, 150 ppm, 190 ppm) in a random order on the same anesthetic event. Following an equilibrium period for each concentration of MS-222, vital functions such as heart rate (via Doppler) and opercular rate were recorded. A response to noxious stimuli in the form of pressure applied to the tail and lip was evaluated and 1 cc venous blood was obtained for determination of biochemical and blood gas values.

A decrease in conscious response to noxious stimulus was inversely correlated to increases of MS-222 concentration, both for the lip and the tail stimulus ($p=0.01$ and $p=1.8e^{-5}$ respectively). Changes in biochemical values were not associated with changes in MS-222 concentration. However, lactate concentration was directly correlated with the length of anesthesia and the number of venipuncture procedures on each fish. Operculation rate decreased with the increase in anesthetic concentration ($p=0.0003$, $r = 0.91$), while heart rate was not affected. This information may assist in establishing anesthetic protocols using MS-222 in fish and may assist in evaluating the positive effect of different analgesics in conjunction with MS-222.

LUPRON (LEUPROLIDE ACETATE) DEPOT USE IN AFRICAN CRESTED PORCUPINES (*Hystrix africaeaustralis*) TO CONTROL INTERMALE AGGRESSION

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Abstract

Leuprolide acetate is a long acting gonadotropin-releasing hormone (GnRH) agonist. Administration initially results in an increase in follicle stimulating hormone (FSH) and luteinizing hormone (LH) causing transiently elevated testosterone.[5] In mammals testosterone suppression usually follows; often approaching zero. Lupron has been used to suppress testosterone and testicular function in Atlantic bottlenose dolphins (*Tursiops truncatus*),[2,3] to prevent breeding and control aggressive behavior in California sea otters (*Enhydra lutris*),[1,5-7] to control undesirable male associated behaviors in California Sea Lions (*Zalophus californianus*),[3,5] to control mating aggression in pelagic stingrays (*Pteroplatytrygon violacea*),[12] and for aggression and birth control in lion-tailed macaques (*Macaca silenus*).[10] It has been shown to lower testosterone levels in black-faced, gray kangaroos (*Macropus giganteus*), African wild dogs (*Lycaon pictus*) and spectacled bears (*Tremarctus ornatos*).[4] It has also been effective in controlling intermale aggression among gray seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) housed together in the same colony (Stremme – unpublished).

Two newly acquired, 2-yr-old, unrelated, male African crested porcupines (*Hystrix africaeaustralis*) began to exhibit aggressive behavior causing wounds requiring veterinary care. Castration was ruled out due to the possibility of future breeding. The monthly form of Lupron was administered intramuscularly to both animals at 0.075mg/kg every 28 days in an attempt to control the aggression. The animals were anesthetized every 4 wk with isoflurane, USP to obtain blood to monitor testosterone levels and in some instances to also give the lupron injections. Serum was sent to the University of Cornell Animal Health Diagnostic Center Endocrinology Laboratory, Ithaca, NY 14852.

Testosterone levels did not drop near zero as expected and aggressive behavior continued. There was no consistent drop in testosterone levels even when the dose was increased to twice the initial dose (0.150mg/kg) and three times the initial dose (0.225mg/kg). In fact, it seemed to rebound and actually increased with the increased dose of lupron. Leuprolide acetate appears to be ineffective in lowering testosterone levels and in controlling intermale aggressive behavior in African crested porcupines.

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AVIAN VENTRICULUS KOILIN AS AN INDICATOR OF DISEASE: A RETROSPECTIVE STUDY

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Abstract

Changes in the koilin layer of the avian ventriculus have been found at post-mortem examinations of many species of birds that died of systemic diseases[1,2]. However, little is known about the relationship between koilin metabolism and the overall health of the bird. Greater understanding of this relationship may allow koilin examination to be an early indicator of subclinical disease. In this study, we hypothesized that the primary diseases diagnosed at necropsy are correlated with specific changes in the koilin. To investigate this, a standard methodology for categorizing the nature and severity of koilin lesions was established and applied to histologic sections of the ventriculus from 140 adult birds in the families Psittacidae, Phasianidae, and Anatidae obtained from the archives of the Diagnostic Center for Population and Animal Health at Michigan State University. These cases were grouped based on the primary disease process found at necropsy, including inanition, septicemia, renal disease, hepatic disease, and alimentary disease. Birds that died from traumatic injury or had no postmortem signs of disease were used as controls. Koilin was graded based on the following parameters: epithelial cell retention, hemorrhage, inflammation, vacuolation, structural organization, luminal surface defects, thickness, and the presence of microorganisms. For most of the parameters evaluated, there were no statistically significant differences between the koilin of control birds and that of diseased birds. Additionally, the Anatidae koilin showed a higher degree pathologic changes overall than the Phasianidae and Psittacidae koilin. There were few statistically significant differences between the Phasianidae and Psittacidae koilin.

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FLUOROSIS IN CAPTIVE GREY-HEADED FLYING FOX (*Pteropus poliocephalus*) ASSOCIATED WITH AN EXHIBIT MISTING SYSTEM

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Abstract

Five grey-headed flying fox (*Pteropus poliocephalus*) housed in a large mixed species exhibit at the National Aquarium in Baltimore developed skeletal fluorosis based on exam findings and diagnostic testing. Initial clinical signs were firm multifocal swellings of digits and long bones and decreased mobility. Radiographs showed significant periosteal proliferation of digits and long bones suspicious of chronic fluorosis as seen at other institutions (D. Ialeggio, personal communication).[1] Bloodwork revealed elevated alkaline phosphatase and hypocalcemia. There was a moderate negative correlation between alkaline phosphatase and calcium values at initial presentation (r = -0.402). Analyses of the animals' diet (as fed with supplements), water, and juice showed low fluoride concentrations (1.77 ppm, 0.86 ppm, and 0.86 ppm respectively). Salt precipitate that collected on the bat roosting wire had very high fluoride concentrations (1065 ppm). Salts formed from the exhibit misting system which sprayed municipal water just above the roosting wire. The salts were consumed by the bats. There was an inverse relationship between animal weight and severity of bone and blood chemistry changes. The animals improved with medical management off exhibit. Bloodwork values were normalizing and bone lesions remained stable to improved several months after cessation of exposure to the exhibit salts. A sixth individual housed off exhibit with no exposure to the salts, maintained on the same diet as the exhibit animals, had no bone changes/lesions and normal blood chemistries. Annual bloodwork review showed abnormalities developed prior to the bone changes and may allow for early detection of cases.

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RECUMBENT RATITES: A NOVEL APPROACH TO PHYSICAL THERAPY

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Abstract

Exertional myopathy has been reported in many animals, including ratites. There are few published cases of successful rehabilitation in birds with exertional rhabdomyolysis.[2,3] Aggressive physical therapy and supportive care have been efficacious when initiated promptly following the inciting insult. Physical therapy in affected ratites may be limited due to the large size of the species and poor patient compliance. Flotation tank devices, such as the Aqua Cow Rise System, have been utilized to treat nonambulatory cattle. The flotation system is filled with warm water that supports the animal's weight, preventing further pressure necrosis and increasing blood circulation to affected musculature.[1]

A 20-yr-old male ostrich (*Struthio camelus massaicus*) presented in sternal recumbency following aggression from a male kudu in a mixed species exhibit. Attempts at slinging the animal resulted in further stress to the bird, and manual physical therapy was limited by the animal's weight and positioning. Physical therapy was provided through the use of a flotation device, which the animal tolerated well. The bird showed improvement in strength and muscle tone in its recovery from exertional myopathy, although this animal died from events separate to the use of this technique. This novel method of providing physical therapy should be considered as part of a multimodal approach to the treatment of recumbent ratites.

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DIAGNOSIS OF ADRENAL GLAND HYPERPLASIA IN A CAPTIVE CHINESE MINK (*Mustela sibirica taivana*) USING FECAL GLUCOCORTICOID ASSAY AND COMPUTER TOMOGRAPHY

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Abstract

A 4-yr-old, 0.78-kg intact male Chinese mink was observed to have bilaterally symmetric alopecia on caudal trunk of the body for 1 yr. Physical exam revealed no external parasites or other obvious abnormalities. The serum hormone analysis indicated a normal level of total thyroxine but an elevated level of serum cortisol (5.0 μg/dl) comparing with the normal average of male ferrets (0.93±0.63 μg/dl).[2] Moreover, a high serum alanine transaminase enzyme value (380 IU/L) was also noted. A fecal glucocorticoid assay, a noninvasive monitoring method of adrenocortical activity, indicated a significantly high fecal cortisol level comparing with European pine martens (*Martes martes*) and other nondomestic mammalian species. [1, 4] The average fecal cortisol value for a monitoring period of seven consecutive days was 3380.71±2798.27 ng/g dry feces. Computer tomography was performed, and a high density image in the left adrenal gland region was clearly identified. A diagnosis of suspected left adrenal gland hypertrophy or neoplasia was made and surgical resection of the left adrenal gland was undertaken. The resected tissue was submitted for histopathologic diagnosis, and the results showed laminar hyperplasia of zona intermedia and nodular hyperplasia of zona glomerulosa of the adrenal gland. Fecal glucocorticoid assay was performed again 2 mo later, and the value had dropped to 2428.19±1197.84 ng/g dry feces. The alopecia slowly resolved and full regeneration of the animal's normal hair coat was present three months post-operatively. Adrenal gland disease is commonly seen in premature-neutering domestic ferrets, and stranguria is occasionally seen in affected males.[3] However, this Chinese mink is an intact male with no clinical signs except alopecia. Fecal glucocorticoid assay and computer tomography provided persuasive evidences for the diagnosis. The response to adrenalectomy in this case was similar to that seen in domestic ferrets.

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IDIOPATHIC MEGAESOPHAGUS IN A RED KANGAROO (*Macropus rufus*)

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Abstract

A 13-yr-old female red kangaroo (*Macropus rufus*) was presented with a history of chronic, intermittent vomiting. The kangaroo was immobilized for diagnostic examination. Complete blood count, serum chemistry, and fibrinogen were within normal limits. Radiographs revealed two mixed density radiopaque masses in the right cranioventral abdomen. The masses were of granular, mineral opacity and were ovoid in shape, with long axes of 10 cm and 5 cm. Exploratory laparotomy performed several days after diagnosis of suspected gastrolithiasis revealed no foreign objects, and intraoperative radiographs confirmed this finding. After surgery, the kangaroo continued to expel ingesta passively, characterizing the clinical sign as regurgitation rather than vomiting. Bloodwork parameters remained unremarkable. Symptomatic treatment with a variety of antiemetics, including parenteral metoclopramide (dosage: 0.2-0.4 mg/kg b.i.d.) and maropitant citrate (dosage: 1 mg/kg s.i.d.) did not decrease frequency of regurgitation. Treatment for gastritis was initiated with parenteral famotidine (dosage: 0.5 mg/kg b.i.d.) and oral omeprazole (dosage: 3.5 mg/kg s.i.d.). Intermittent episodes of presumed gastric tympany with audible borborygmus were treated with chewable simethicone tablets (dosage: 9 mg/kg b.i.d.), which the kangaroo consumed readily. Pain related to these episodes was managed with flunixin meglumine (1 mg/kg s.i.d.) and butorphanol (0.3 mg/kg prn). A barium study revealed esophageal dilation with suspected decreased esophageal motility. Diagnostic tests for hypothyroidism and myasthenia gravis were negative. Symptomatic treatment for megaesophagus was initiated by feeding gruel from an elevated platform and frequent hand-feeding, which required the kangaroo to extend vertically. The kangaroo continued to lose weight despite showing a good appetite, and endoscopy performed under anesthesia confirmed a severely dilated esophagus that contained a moderate amount of ingesta and fluid despite a 12-hr fast. On necropsy, the proximal 30 cm (about 50%) of the esophagus was severely dilated and had thin, flaccid walls. The esophagus became more normal in appearance at the diaphragmatic hiatus, although no stricture was evident. Esophageal histopathology revealed chronic, multifocal myofiber degeneration with fibrosis. Aspiration pneumonia, a common sequela to megaesphagus, was also diagnosed on histopathology.

Vomiting occurs occasionally in macropods through a process termed merycism. In this process, ingesta moves up the esophagus and into the oral cavity through obvious abdominal contractions that appear as heaving. Typically, the ingesta is swallowed immediately rather than chewed, and some material may fall from the oral cavity.[7] Although a few episodes of heaving were described in this kangaroo, the predominant clinical sign was simple regurgitation with no perceptible abdominal contracture, pointing to the esophageal etiology. To the author's knowledge, megaesophagus has never been diagnosed in a macropod. Megaesophagus has been described in several large animal and exotic species, including a Bengal tiger, a wood bison, and

a llama, but in all of these cases, megaesophagus was diagnosed as a consequence of persistent right aortic arch.[1,4,5] No such vascular anomalies were apparent in this kangaroo. Myasthenia gravis has been previously diagnosed as a cause of megaesophagus in a ferret, polar bear, and Siberian tiger.[2,3,6] In all of these cases, serum acetylcholine receptor (AChR) antibody levels were assessed at the Comparative Neuromuscular Laboratory of the University of California San Diego and were well above canine and feline reference ranges. In the polar bear and tiger cases, serum AChR antibody titers were also several times higher than those of healthy conspecifics.[3,6] Although normal ranges for AChR antibody titers have not been established in macropods, antibody levels for this kangaroo were far lower than canine and feline references intervals for myasthenia gravis positive animals. The titer was also comparable with levels from a juvenile, healthy female red kangaroo, making myasthenia gravis highly unlikely as the cause of megaesophagus in this case.

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