



# Giraffa

## Newsletter



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*Note from the Editor*

Another year has passed and the festive season is upon us – for some more than others, as I write this at 35°C! Whilst we look forward to a solid rest, sadly the same cannot be said for all giraffe across Africa. The numbers of giraffe in Botswana are reported to have dropped in some populations by more than 65% while those in the Central African Republic continue to dwindle, and the sad song goes on. And again reality hits: we still know so little about so many things!

To be proactive we held the first-ever 'wild' Giraffe Indaba in Namibia in early July this year and this was an extremely productive and positive meeting of like minded people. The Indaba enabled us to discuss research, conservation and management of giraffe, as well as to chart a 'road map' for the species' future conservation – watch this space!

This issue brings you the best of the Giraffe Indaba (most conference posters and full presentations can also be found on the GCF website [www.giraffeconservation.org](http://www.giraffeconservation.org)) as well as some other interesting stories and updates.

In the spirit of collaboration and coordination – something which the giraffe world is credited for – *Giraffa* is now a combined publication of the IUCN SSC ASG International Giraffe Working Group (IGWG) and the Giraffe Conservation Foundation (GCF).

Lastly, but certainly not least, the GCF are developing a giraffe digital library. Read more about this project inside on page 31 and hopefully you can contribute to building a resource for all giraffe folk out there.

Happy holidays to all and look forward to a new and exciting year of all things giraffe in 2012 – and beyond.

Julian Fennessy  
Chair IGWG & GCF Trustee

Newsletter of the IUCN SSC ASG International Giraffe Working Group (IGWG) & the Giraffe Conservation Foundation (GCF)

**Objectives**

**IGWG:** To define the taxonomy of giraffe with respect to the historic classifications as seen today across the African continent blending traditional taxonomic morphometrics with molecular genetic techniques and to establish the effect of habitat fragmentation and reduction on conservation management decisions for the future success of the species.

**Giraffe Conservation Foundation (GCF)**

is dedicated to securing a future for all giraffe populations and (sub)species in the wild.

## Giraffe Indaba – A world first held in Namibia

Andy Tutchings, GCF

History was made in Namibia in 2011, when GCF organised and sponsored the world's first ever conference dedicated to the wild giraffe. The conference took place from 4 -7 July at the Etosha Safari Lodge, just south of Etosha National Park.



Giraffe Indaba delegates take a break to mark this historical event with a team photograph.

And it could not have been more auspicious timing. As delegates flew into Namibia from around the world, researchers announced that giraffe populations in northern Botswana had plummeted by an astonishing 65% over the last 10 years. This frightening number far exceeds continent-wide estimates of the other (sub)species which suggest at least a 40% reduction of giraffe numbers during the same period. Grim news indeed, but it added an additional sense of urgency and purpose to this unique gathering of international giraffe experts and researchers who had flown in from as far afield as Japan, Australia, the USA, and Europe as well of course from across Africa.

As delegates relaxed with their well deserved sundowners after long travelling times, they enjoyed the magnificent views across the expanse that is Namibia, a country whose resident (sub)species population, *Giraffa camelopardalis angolensis* is alone in bucking the continent wide trend with numbers actually increasing – though it is fair to note that this 'Angola giraffe' as it is commonly known may no longer occur over the border in Angola!

Formally opened with a scene-setter and warm Namibian welcome by Werner Kilian, Director of the Etosha

Ecological Institute, Ministry of Environment and Tourism in Namibia, the conference agenda and its relevance was made abundantly clear. There followed three days of fascinating presentations and delivery of research papers covering a breadth of topics, from poaching proliferation and lion predation; ecological, social and gender issues to

the very latest in computer assisted identification software and methodology. All of which led seamlessly into the interactive afternoon workshop sessions on taxonomy, genetics and research technology, with many of these discussions extending late into the evening around the open fire.

It was abundantly clear from the conclusions to many presentations and certainly as a result of the forums, that there remain a worryingly large

amount of questions about giraffe research and conservation management still unanswered. Largely, it would seem, because in many cases the questions have never been raised before; the giraffe has simply been 'forgotten'! For example, it still comes as a surprise to many that GCF's expedition to Botswana was, and remains, the only dedicated giraffe research undertaken in this country to date. Appropriately entitled *Giraffe: The Forgotten Megafauna*, it is clear that this Indaba, the first ever of its kind, was long overdue and could not have come at a more critical time. With giraffe numbers across



Some of the Indaba delegates enjoying their welcome sundowners at the Etosha Safari Lodge, overlooking the expanse that is Namibia with Etosha National Park in the distance, excited by the week that lay ahead.

the continent estimated below 80,000, down from some 140,000 at the turn of the century, there is a clear requirement to reverse, or at least halt, this alarming decline.



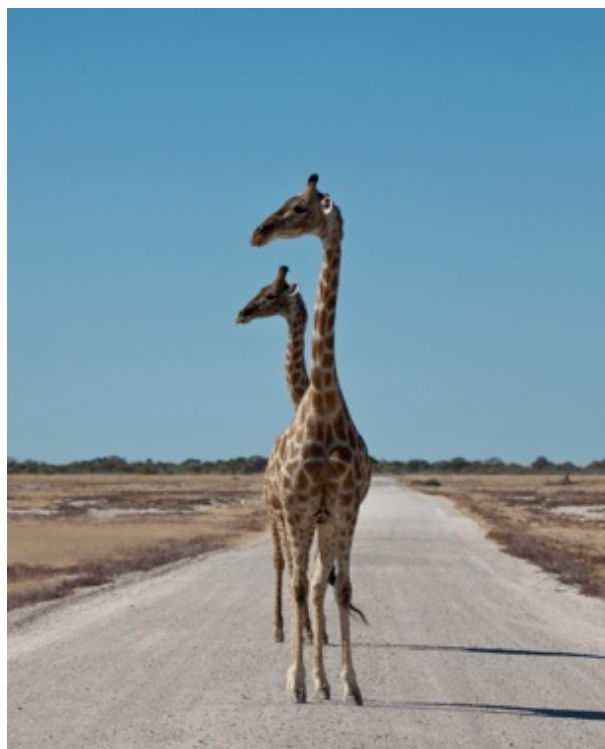
GCF's Dr Julian Fennessy overseas one of the groups' discussions during the Indaba highlight; drawing up a framework strategy document for conserving Africa's giraffe populations.

As a direct result of the work and campaigning by GCF, since 2008 two of the recognised nine (sub)species have been formally Red Listed by the IUCN as Endangered (West African: numbering less than 250 individuals ; and the Rothschild's: numbering 670 individuals). Regrettably other giraffe may be in similar peril including the Reticulated giraffe in East Africa which number less than 5,000 individuals; the Kordofan giraffe may survive across war torn central Africa but their numbers remain unknown; the geographically isolated Thornicrofts giraffe in Zambia's Luangwa Valley are barely stable at some 1,500 individuals; and most concerning is the Nubian giraffe (the nominate subspecies) with numbers possibly less than a few hundred! And so it goes on.

It is of little surprise then that the highlight of the Indaba was the final day's workshop run by the world's foremost authority on giraffe, Dr Julian Fennessy. The aim of this forum was to establish a long overdue 'road-map' document, detailing short- to medium-term research goals focussing specifically on the long-term understanding of giraffe in their natural habitat, and essentially developing a conservation management strategy framework. The resulting document will be published shortly, but the seminar proved to be the ideal conclusion to a thoroughly successful conference. Refreshing for many by virtue of its cooperative and inclusive nature, all of the delegates left inspired and

motivated by the tone and outcome of the conference, assured they are working towards a common goal with a new found group of friends, though intensely aware that there remains an enormous amount to be done, and the hard work starts today!

The author would like to thank the Indaba's in-county host, the Namibia Nature Foundation, as well as the all-important event sponsors: Wilderness Safaris, Wilderness Safaris Trust, Africa Geographic and Blank Park Zoo.



Where do we go from here? A road map document for the conservation management of all giraffe (sub)species is essential if we are to preserve this African icon.

**Contact:**

Andy Tutchings  
andy@giraffeconservation.org

Julian Fennessy  
julian@giraffeconservation.org

All poster and presentation abstracts from the Giraffe Indaba can be found in this issue of *Giraffa*.

During the Indaba delegates requested that this conference should become a biennial event. Watch this space and the GCF website ([www.giraffeconservation.org](http://www.giraffeconservation.org)) for more information on the next Indaba in Kenya in 2013!

## A picture is worth a thousand words: studying demography of Masai giraffe using photographic mark-recapture

Derek E. Lee & Monica Bond, Dartmouth College & Wild Nature Institute

The iconic giraffe (*Giraffa camelopardalis*) is the national animal of Tanzania and a highly visible indicator of the health of savanna ecosystems. Despite the world-wide popularity of giraffe, little is known about the demography of the species and how their survival and reproductive rates respond to predation, disease, changing land uses, and poaching. The semi-arid savannah-woodland of the Tarangire-Manyara Ecosystem (also known as the Maasai Steppe Ecosystem) lies in the eastern branch of the Great Rift Valley in northern Tanzania (Fig. 1) and supports not only giraffes but one of the most diverse communities of ungulates in the world. Aerial surveys have demonstrated that populations of Masai giraffe (*G. c. tippelskirchi*) in the region have declined since the late 1980s yet surprisingly few data exist to guide management of this cherished icon, thus we have no strong inferences about the demographic or ecological causes of observed declines.

Giraffe are facing a barrage of threats in the Tarangire-Manyara Ecosystem. Since the 1940s, human population and agricultural expansion outside of Tarangire and Lake Manyara National Parks have increased four to six-fold, reducing the connectivity in the ecosystem and causing substantial habitat loss and fragmentation. Estimates of the portion of the Tanzanian giraffe population removed by illegal poaching range from 18 to 40% (Caro 2008, Waltert et al. 2009). Moreover, Giraffe Skin Disease is a newly observed disease affecting skin on the legs of giraffes in Tanzania. Giraffe Skin Disease was first recorded in November 2000 in Ruaha National Park in central Tanzania. Currently the disease has spread to all parts of Ruaha and has been observed in Tarangire and Lake Manyara national parks. Causative agent and epidemiology of Giraffe Skin Disease are yet to be established, but adverse effects including increased risk of predation and secondary infections are strongly suspected.

Our studies use photographic mark-recapture and computer-assisted animal identification technology called Wild ID recently developed by Dartmouth College researchers Doug Bolger, Bennet Vance, and Hany Farid. The software and documentation can be freely downloaded at: <http://www.dartmouth.edu/~envs/>

faculty/bolger.html. We have launched a multi-year intensive study of Masai giraffe demography and Giraffe Skin Disease epidemiology in the Tarangire-Manyara Ecosystem.

When combined with free mark-recapture modeling software (e.g., program MARK), computer-assisted photo-identification provides a powerful, inexpensive method for estimating demographic and movement parameters and testing hypotheses about ecological mechanisms affecting demographic rates. The main benefit of computer-assisted photo-matching in a mark-recapture context is that it can be used to “mark” and “recapture” (re-sight) large numbers of individuals, which increases the recapture rate in models, improving the power of demographic estimates, and allowing a greater number of parameters to be estimated. The use of photographic data enables us to track large numbers of individuals reliably without subjecting them to stressful capture and marking procedures. With simply a car, a camera and a computer anyone can use our methods to start a successful, low-cost, fine-scale demographic study of any giraffe population in Africa.

Our research team, in collaboration with Dr. Bernard Kissui of African Wildlife Foundation, are collecting photographic mark-recapture data on giraffes in the Tarangire-Manyara Ecosystem three times per year in five spatially distinct areas with different habitat, poaching, lion predation, and disease characteristics. We are estimating population size, reproductive success, juvenile survival, adult survival, and movement probabilities at each site, and will test for differences in these vital rates according to site, protected area status, lion density, nearby human population, vegetation characteristics, and prevalence of Giraffe Skin Disease. We have already detected differences in population size, detectability, adult sex ratio, and cow/calf ratios among our study sites. Conclusions on the magnitude and importance of disease, poaching, and habitat effects on vital rates will be disseminated to wildlife authorities, land managers, and conservation NGOs to guide policy decisions aimed at conserving viable giraffe populations in the Tarangire-Manyara Ecosystem and throughout their range.

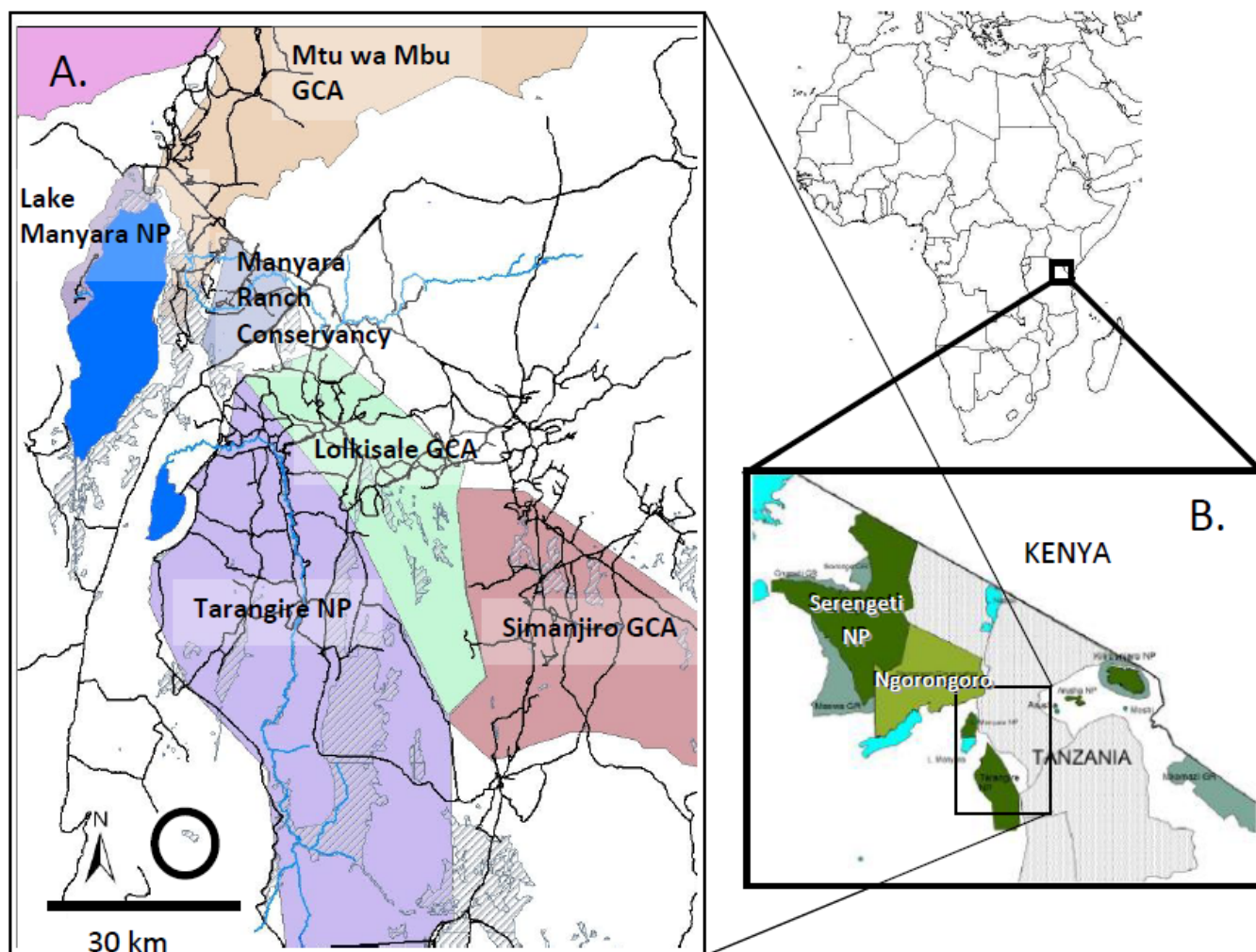


Figure 1. A. Map of Tarangire Ecosystem study area showing sites (colored polygons), roads (black lines), swamps (diagonal hatched areas), rivers and lakes (blue lines and areas). Black circle above scale shows average adult female giraffe home range size ( $96 \text{ km}^2$ ). B. Study area inset in map of northern Tanzania showing National Parks (dark green), Ngorongoro Conservation Area (light green), Game Reserves (dark grey), and Maasai pastoralist lands (light grey).

**Contact:**

Derek Lee

1dereklee@gmail.com

## Giraffe return to their old stomping ground

Zoe Muller

*Why did the giraffe cross the lake? It sounds like a bad joke, but this became reality for a towering octet of graceful giraffe in Kenya earlier this year. The Giraffe Conservation Foundation's Zoe Muller was there to witness history in the making and find out if it really was "to get to the other side...."*

There was an air of nervousness as first light slowly broke across the muddy waters of Lake Baringo. The only sounds to be heard were the gentle creaking of the old barge as it rocked on the gentle ripples of the lake and the deep, rhythmic breaths of the eight large creatures standing nearby, blinking into the dawn and unknowingly becoming a part of conservation history.



It was the early hours of 7<sup>th</sup> February 2011 and we had all gathered on the shoreline of Lake Baringo, one of the largest lakes in Kenya's Great Rift Valley, to witness a spectacular conservation success story as it unfolded. This was a day that had been planned for several years and finally the moment was here – the day that eight Endangered Rothschild's giraffe (*Giraffa camelopardalis rothschildi*) were to be moved to their new home in the Ruko Conservancy, located on the shores of Lake Baringo.

The Rothschild's giraffe was once free-ranging across much of western Kenya and the Great Rift Valley, but decades of persecution, increased human settlement, agriculture and accelerated habitat loss have had a major impact on this giraffe sub-species. There are now thought to be less than 670 individual Rothschild's giraffe left in the wild, a figure which recently prompted the IUCN to upgrade their conservation classification to Endangered. Once widely distributed around Lake Baringo (the Rothschild's giraffe is also referred to as the Baringo giraffe) there have been no giraffe in this area for at least 70 years. So this translocation operation was planned as a major move towards reintroducing this giraffe sub-species

back into the area, working towards reclaiming some of their former range.

The translocation operation has been at least four years in the planning – moving such large animals involves a lot of forethought and organisation – but the hard work paid off and plans were finally developed for moving these giraffe. Despite being so apparently laid back, giraffe have a tendency to get stressed out when required to do anything more than eat leaves and wander around the savannah and so the entire operation was carried out in stages in order to minimise the stress to the animals and increase the chance of success. Soysambu Conservancy was selected as the source population and so eight fit and healthy individuals were selected for the move.

Following three days of high action, intense capture operations, all eight animals found themselves a little confused as to what had just happened, but nonetheless safely ensconced in a boma (holding area) at Soysambu Conservancy where they were held for three weeks to recover from their stresses, before they were moved 160km north to their new release site, Ruko Conservancy. The Ruko Conservancy lies on the shores of Lake Baringo and is inaccessible by road, affording it a high level of protection – the only way to get there is to travel by boat across Lake Baringo. The Conservancy is a community driven initiative which aims to restore the region's wildlife and biological diversity. It is being coordinated and operated by the local communities and aims to increase tourism in the area which will in turn drive more conservation action. Not only will Ruko provide a protected habitat for a number of animals, it will also attract income to the local area, provide employment, and inspire the future generation.



Following a three-week calming down period post-capture, all eight giraffe were loaded into a specially

designed 'giraffe mover' (i.e. big truck!) and transported the 160km by road from Soysambu Conservancy up to Lake Baringo, ready to complete their final journey to their new home. Despite a 10-hour journey across bumpy roads, and careful avoidance of the low-slung power cables so increasingly prevalent in Africa, the giraffe arrived at Lake Baringo in good condition and apparently very calm. Only one challenge remained: how do you get eight giraffe across on of Kenya's biggest lakes?!

Moving giraffe across a lake, or even putting a giraffe on a boat has never been attempted before, and given their reputation as easily-stressed and fragile creatures, needless to say everyone was slightly on edge. Teams of conservationists, vets, animal translocation experts and a myriad of other helpers had worked tirelessly throughout the night to get to this point. The journey had started at Soysambu at 11pm the night before when all eight animals were loaded up, driven here and arrived just as dawn was breaking. Standing on the lake shore that morning in the first rays of sunlight, the calm and serene surroundings belied the tension felt by all involved as we stood looking at the vast expanse of water and thought, "how is this going to turn out?".

However, the professionalism and immense knowledge and experience of the capture team shone through and the magnificent vessel that was to be used to transport the giraffe across the lake was unveiled – an old, converted barge with a central holding area for the giraffe and canoes at either side to keep the vehicle stable in the water. However, the vessel had not been tested with a giraffe in before and so we stood with bated breath as the first pair of hooves found their way onto the barge. The vessel held out and a few more pairs of hooves later, four giraffe were safely loaded and ready to begin their voyage! It had already been decided that we should move the giraffe in two batches of four giraffe and so the first lot were ready to go.



© Zoe Muller

The Soysambu giraffe did us proud and appeared to deal with the matter in a serene and muted way, apparently

unaware that they were sailing across a huge Lake making history as they went. The lake crossing took approximately sixty minutes, during which the arrival bay on the other side at Ruko Conservancy was prepared. This was basically a long, canvas chute which would be hooked up to the barge upon arrival and used to 'channel' the giraffe into their new home inside the Conservancy. When the boat containing the first four giraffe arrived, we were all surprised to see just how calm the animals looked, slowly looking around and apparently taking in their new environment.



© Zoe Muller

However, having stood for so long and so patiently on the truck and then the boat, the animals' enthusiasm to get moving again became evident as soon as the barge crate doors were opened –there was a clatter of hooves and all four giraffe burst off the barge and went galloping up the canvas chute, straight out into their new found freedom. This was accompanied by a huge cheer from the substantial crowd that had gathered and everyone was left breathing a huge sigh of relief that the operation went smoothly. The second batch of giraffe were much the same, the crossing was smooth followed by an explosion of muscle and long legs as they galloped to join their friends upon reaching terra firma.

The day ended with a tired and weary translocation team making their way back to the mainland across the lake, supported by a cool box full of Tuskers and celebratory noises all round. The result of four years of planning and a lot of hard work, one of Africa's most challenging and potentially risky animal moves had just been successfully executed and the Baringo giraffe has finally found its way home. In the future, we hope that this population will establish itself, grow and ensure that giraffe are found in this area of Kenya for many years to come.

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**Contact:**  
Zoe Muller  
muller.zoe@gmail.com

## Knowsley Safari Park 40<sup>th</sup> Birthday Lecture: 'All about giraffes'

Paul Rose

### Background

Knowsley Safari Park, situated just outside of Liverpool in the UK was founded by the 18<sup>th</sup> Earl of Derby in 1971. Two Thousand and Eleven sees the Safari Park's 40<sup>th</sup> birthday and I was very kindly invited to give a presentation on giraffe-focused research, conservation and management as part of a series of lectures celebrating this milestone. The proceeds from my talk, around £340.00 have all gone to support the work of the Giraffe Conservation Foundation.

The information I presented highlighted the work of the GCF in the field, especially focusing on the Niger giraffe project (special thanks to Jean-Patrick Seraud for providing extra details on his research in this area) as well as a range of current *ex situ* initiatives designed to provide a better understanding of giraffe biology. To try and cover all bases I attempted to 'marry together' the work being done in the wild world with that undertaken in captivity, thus giving my audience of around about 50 zoo keepers, students and those with a general interest in the subject an overview of current issues and conservation work. A synopsis of the information presented follows.

### Nutrition

Giraffe are a notoriously difficult species to feed correctly in captivity; poor acceptance of their forage ration, limited availability of natural 'browse' (cut tree branches) and a reliance on concentrate rations to provide essential nutrients, minerals and vitamins can cause upset to the delicate digestive physiology of the giraffe. An 'eye for detail' is required to keep watch to any changes in body condition in captive animals that could be indicative of poor health. Key areas to focus on are changes to the appearance of the giraffe's neck, feet and skin/coat. Body condition scoring is an easy tool that those managing captive giraffe can utilise to provide a quick assessment of health and welfare. Alterations to neck shape and bone prominence are a reliable way of checking that metabolic demand is being maintained by nutrient provision. Giraffe are prone to multifactorial wasting syndromes and hence it is of the greatest importance that a close eye is kept on feed intake, overall condition of each animal and any changes away from normality. With limited fat reserves,

giraffe can quickly slip into an energy deficit if feed intake is not meeting energy demand or metabolic requirement. Foot (hoof) overgrowth with a nutritional basis can manifest as laminitic changes to horn growth that are indicative of physiological disruption, which will need immediate correction to prevent long-term health problems. It is always important to bear in mind that when developing diets for zoo-housed giraffe (indeed as for any ruminant) it is the microbial flora within the gut that needs to be nurtured and maintained in a stable environment. Diets that disrupt the workings of these microbes and reduce the capacity of the giraffe to digest and assimilate nutrients from its food can cause potential energy imbalance, loss of condition and has the potential to kill the animal.

The use of forage rations that are ideal for grazing animals (i.e. grass hays) should be used with caution for giraffe as the anatomy of the giraffe's rumen is not able to cope with the layering (stratification) of forage that occurs post-ingestion. Such stratification can block the passage of ingesta through the stomach as a whole, and whilst the giraffe may appear to be eating normally, overall nutrient uptake can be reduced and the animal will lose weight and condition. As zoos think more about evidence-based management and look at facets of natural biology or evolutionary ecology when designing appropriate and long-term husbandry regimes, the key relationship between the giraffe, its evolutionary niche and its adaptations to eat a range of dicotyledonous plants and tree-based vegetation needs to be at the forefront of this. Legume forage (such as alfalfa/lucerne) should be regarded only as the best currently available alternative for natural browse rather than a complete substitute; collections should attempt to include as many cut tree branches or derivatives of browse (ensilaged leaves for example) in their giraffe's daily diet as possible. Providing that a sensible ratio of concentrate pellet (fed as a percentage of bodyweight appropriate to each individual) to forage to browse is provided, nutritional problems can be prevented as far as possible.



## Social behaviour

'Facebook for giraffe' was the approach I took to explain the current work that I have been involved in, mainly with the Rothschild giraffe herd house at Marwell Wildlife, Winchester, UK investigating the social bonds between female giraffe. Mutual relationships (one can define them as 'friendships') are important to individual welfare and health, and work extrapolated from other species shows that individuals gain adaptive benefits from having such 'friends' throughout the course of their lifetime. My attempts, with the work that has been carried out at Marwell, has been to determine what bonds are present between individuals in the giraffe herd and whether or not these bonds are stable over time. Little is known about the social organisation of giraffe, both in the wild and in captivity but current projects are underway to shed light on how giraffe associate with one another, and what they 'get' from these social interactions. Whilst it still can be seen in numerous texts that giraffe have a loose, fluid or poorly-defined social structure, study performed on zoo-housed giraffe, including the research that I have conducted since 2007, has shown that giraffe do have a defined social system centred around the stable and long-term relationships that exist between adult females within the herd. The results of these investigations mirror what is being found out from wild studies into giraffe social systems, indicating that some facets of wild sociality do transfer over in the captive environment. Female giraffe have specific preferred partners and associations between two specific individuals are not random; one giraffe will preferentially seek out the company of another, and the behaviour of these friendship groups can influence the behaviour of the whole herd overall. Bonds between adult females are not altered by reproductive events (courtship, copulation, pregnancy, parturition and nursing young), thus showing the strength of the apparent relationship that is being maintained.

The work that I have also implemented has shown that movement of individuals into and out of zoological collections for breeding purposes (i.e. on behalf of the studbook) can affect breeding potential of the individual and hence overall lifetime reproductive success. It appears that there is a direct correlation between the number of times a giraffe is moved and the number of successful breeding events that she will be part of. Whilst management of breeding (and indeed overall population

management) is very important, this purported link between movement events and reproductive success needs further investigation to determine the strength of this relationship.

Another notable finding from the work that I have performed is that bonds between youngsters are also well-defined and can be stronger than between those that exist between mother and calf. Calves will group together during the day and actively seek out each other's company; perhaps mirroring the crèche system that has been seen in the wild whereby young giraffe will group together for security. The notable point from this finding is that if giraffe calves do gain benefits from being in a group and that these relationships are important to individual's enhanced welfare (with all of the benefits that this brings later in life) perhaps zoos should consider maintaining larger breeding herds that can contain within them more than one calf at a time, thus providing for this apparent behavioural requirement.

This work into the social requirements and social structure of captive giraffe is on-going to continue to shed light on the effect of management decisions and husbandry practice on giraffe social behaviour in the zoo. As appears to be evident so far, female giraffe are more reproductively successful when they are not moved around different collections and that giraffe in a stable herd have an increased lifetime reproductive success, thus providing new avenues for research to investigate in the future. Using non-invasive measures of physiological stress (via faecal glucocorticoid analysis) provides an insight into the long-term and short-term effects of changes to immediate environment (social and physical) on the individual giraffe. The results of these investigations will appear in due course.

## Exhibition in the zoo

Giraffe are a popular zoo exhibit due to the educational story they tell and the conservation issues surrounding specific subspecies; here I reviewed the ways in which giraffe can be displayed and the importance of public interpretation to promote the reason behind maintaining such enigmatic species in a captive setting. The role of the modern zoo is well known and their duty to provide an educational experience for visitors is something that all modern, well-run collections strive to do. Collections in the EAZA region focus *ex-situ* conservation work on two subspecies primarily, the endangered Rothschild's giraffe

and the reticulated giraffe. Giraffe can be an excellent 'honeypot' and 'storybook' species that zoos can use to successfully highlight their work conserving not only the species itself but also the environment that the species inhabits, and thus increase public perception of the zoo's role in preserving the natural world.

Exhibition of giraffe in naturalistic as well as mixed-species exhibits is becoming more and more common. Indeed the old style 'single-species' giraffe house with its bare paddock and limited furnishing is fast becoming a thing of the past. The public respond well to naturalised exhibits that portray species in a setting that can capture elements of species' natural ecosystems however this can be difficult with such large and potentially destructive species. Likewise, the mixing of species from the same zoogeographic or ecosystem area together is also becoming common place and giraffe can often be seen in the same enclosure as antelopes, equids, rhinos and birds from the African plains. Such multispecies enclosures provide a new dimension for the visiting public, explain key points of natural and evolutionary biology of the species housed and can immerse the public in a key message that the zoo wishes to promote, adding more value to the zoo's educational programme. However, multispecies exhibits housing giraffe need to be carefully planned; it is not simply a case of recreating a small piece of Africa, species need to be chosen carefully on the guidance of space and facilities available as well as considerations of the individual temperament of the animals that will be mixed together. Whilst generally inquisitive yet placid animals, giraffe can be responsible for negative interactions in mixed species displays and it is important to manage all of the species within the enclosure differently for their own requirements, even if they share an outdoor space. This point is especially true during times of courtship, parturition and the rearing of young.

As stated earlier, the giraffe lends itself well to a range of educational stories that the zoo can tell to the public. The 'ark paradigm' of preservation of species against an uncertain future is perhaps one of the best known and captive breeding programmes are heavily promoted to the public to ensure that the 'zoo message' is accessible to all visitors. What does seem to the case however is that the diversity of information presented between some zoos that houses giraffe differs greatly. Consequently

current work by members of the IGWG is hoping to standardise the information presented in zoos that gives a coherent message to visitors about giraffe biology, behaviour, classification and ecology, as well as conservation status. Promotion of the conservation importance of captive populations of subspecies such as Rothschild's giraffe is extremely important. The zoo-housed world population of Rothschild's giraffe is large enough and viable enough to be of real conservation significance; by providing an intelligible and relevant message to the zoo-going public the value of these captive individuals will be further increased.

### Genetic analysis

As well as explaining the work that has been performed with captive giraffe, I also reviewed the work that has been undertaken in the wild to identify the genetic characteristics of endangered giraffe populations, specifically that performed in Niger on the *peralta* (West African) giraffe population. This assessment of the genetic characteristic of wild herds has shown that giraffe subspecies maintain themselves as genetically isolated populations, an important point for those working with captive herds. If wild giraffe subspecies do not hybridise freely, this puts a greater onus on breeding management of giraffe in the zoo to prevent the creation of hybrids and to maintain the specific genotypic and phenotypic differences of individual subspecies that we are trying to preserve. As those working in the field will be aware, there is current debate as to the genetic status of individual giraffe subspecies, centred around ideas that (potentially) subspecies maybe genetically different to such a degree that they can be classed as full species. Such an idea will also have far-reaching consequences for zoo-housed populations and require more intricate future management to preserve genetic diversity; now read back to the paragraph on social interactions and how giraffe may prefer to spend time with one specific individual and you will see why difficulties may emerge in future...

### Marrying up *in-situ* and *ex-situ* work

To summarise, I attempted to interlink the work on-going in the wild with that evident in captivity. Research into behavioural ecology is very easy to carry across each area of work (wild and captive) and as zoo animal husbandry becomes more and more evidence-based, the work of field researchers will be used ever more increasingly to determine management regimes. The investigative

research that is supported by the Giraffe Conservation Foundation in Botswana, Namibia, Kenya and Zambia, as well as that in Niger, provides a strong benchmark that can be followed by those assessing the welfare, behaviour and health of captive herds. The more that is known about giraffe ecology and natural history across Africa, in different herds in different habitats, then the better placed we will be to understand the requirements of those individuals in zoological collections and consequently provide more appropriately for them.

Conservation initiatives should have a strong human element; creation of long-term sustainable giraffe populations can only be successful with the help and involvement of local communities in the range-states in which the giraffe occurs. This theme is a strong element of the Giraffe Conservation Foundation's work and again, another aspect that translates well into the work of captive collections. I reviewed the work of the Niger giraffe project, whose aims, amongst others, are to ensure a prosperous future for the people that live and work alongside of the giraffe in this area of Africa. Radio collar tracking of individual giraffe allows a precise evaluation of

their movements and habitat choice; where animals chose to go will directly impact on the level of human interaction they experience. Ensuring such human interaction is positive or simply benign will ensure giraffe continue to survive and populations can expand in this fragile environment. Whilst there are no West African (Niger) giraffe in captivity, zoos can still play a large role in promoting the vital work of *in-situ* conservation, and can link their own campaign work to that on-going in Africa with these endangered populations, again further enhancing the role of the giraffe that they maintain.

For more information on Knowsley Safari Park's research and conservation activities visit

<http://www.knowsleysafariexperience.co.uk/?/research-and-conservation/research-and-conservation-home.html>

**Contact:**

Paul Rose MSc

[paul.rose@sparsholt.ac.uk](mailto:paul.rose@sparsholt.ac.uk)

## Gentle giraffes face tall order in Garissa

Joe Ombuor

The civil war in Somalia has resulted into an influx of refugees into northern Kenya, which has had a negative effect on wildlife. Dadaab in Garissa District hosts 440,000 refugees and it is the largest concentration of the displaced in the world. The area has three refugee camps, namely Ifo, Dagahaley and Hagadera and there are already plans to open Ifo II to host refugees escaping famine and violence in the wartorn country.

The country has not had a stable Government after the ouster of President Siad Barre in 1991. Hosting such a high number of refugees has had some negative effect on the people of North Eastern Province and the country. Wild animals have not been spared either. Some of the refugees who escaped into Kenya smuggled firearms into the country which they use to poach to supplement their food.

Felling of trees to put up makeshift shelters and the increased demand for wood fuel has also greatly destroyed wildlife habitats. It is these activities that led to

some wildlife migrating to safer areas around Garissa Town and the Tana riverine in the late 1990s. The area boasts of lush vegetation and adequate water supply, thanks to the River Tana.



### Sanctuary is born

With time, the area became a haven for giraffes and other browsers such as gerenuk, dik dik and lesser kudu. First to arrive at the sanctuary was a colony of 30 giraffes, some of which, residents say, had bullet wounds. With adequate protection and abundance of acacia trees around Bour Algi area close to the town, more giraffes streamed in, leading to village elders mooted the idea of establishing a sanctuary.

The co-founder of the sanctuary aptly named Giraffe Conservation Foundation, Abdullahi Hussein Ali, the facility, which was started in 2000, covers about 125sqkm in Garissa County. He says the establishment of the facility and bolstered security saw more giraffes troop to the sanctuary.

"The giraffe population at the sanctuary increased fast, leading to recognition by the Kenya Wildlife Service," says Mr Ali. Ali has also been spearheading efforts to sensitise the Somali community on the importance of taking care of the facility. "I have worked with the locals here for the past five years to ensure they continue to support and accommodate giraffes," he says. His efforts have seen the foundation train community scouts on wildlife and conservation techniques.

### Long-term conservation

"I am working hard to foster long-term conservation through education and outreach," he told The Standard On Saturday. He says human encroachment, infrastructural development, charcoal burning, and sand

harvesting are some of the challenges facing the sanctuary.

The biologist also laments that a sewerage project in Garissa has polluted breeding and feeding sites, fueling migration of giraffes to unsafe areas. He also decries the continued blockage of dispersal routes and water corridors through expansion of farmlands. Ali criticises the National Environment Management Authority (Nema) for sanctioning the sewerage project, which he says is a major threat to the sanctuary. "We question how the National Nema approved such a project to be carried out in giraffe concentration area," poses Ali, who is also a researcher.

### Sustainable measures

Ali warns that the sanctuary could be lost altogether if long-term measures are not instituted to protect it and also make it sustainable. "Tourism related infrastructure and environmental education need to be put in place and bylaws governing the sanctuary strengthened," he says.

Ali, who was born in Garissa, has been involved in many conservation projects in North Eastern Kenya and western Somalia. Besides the giraffe sanctuary, he was involved in the establishment of the Ishaqbini Hirola Conservancy where he researches on the conservation of the IUCN Red-Listed hirola (*Beatragus hunteri*), one of the most endangered antelopes in the world.

This article was originally published in The Standard, 9 September 2011.

## Vale Professor John Skinner 1932 – 2011

Graham Mitchell, University of Wyoming

John Skinner died on 28 August 2011 after a long illness. He was one of the world's foremost zoologists and was especially concerned with understanding the anatomy and physiology of wild animals. He started out as an animal scientist working on the development of the famous Bonsmara breed of cattle under the supervision of the legendary Jan Bonsma. He obtained a PhD from Cambridge University for a study of reproductive endocrinology of livestock, but having returned to South Africa he was appointed Director of the newly established

Mammal Research Institute at the University of Pretoria, which he headed for 26 years. Under his direction the Institute became the best known centre for mammal research in South Africa and one of the best known in the world. The direction he gave the many students and scientists who studied there was to research the lifestyles of animals. Over the years this grew into studies ranging from the effect of male hormones on growth in piglets, to his cardinal contribution to the science behind the successes and the failures of game farming as a source of

meat for Africa. He became expert on three species – springbok, hyenas and giraffe. His giraffe research started with Anthony Hall-Martin and it was definitive. At the time in the early 1970's there was very little known about giraffe anatomy or physiology and they took the opportunity of a large cull in the Timbavati Nature Reserve to correct the deficiency. Their work laid the foundation of much of what is known about this extraordinary animal. The study was wide-ranging in that it covered endocrinology, feeding habits, body composition, and foetal growth. Over the years he focused more and more on giraffe anatomy and physiology guided by the principle that the more that was known about the physiological needs of a free-living animal the better the advice that could be given on its conservation.

He was prolific author and published over 350 articles as well as writing and editing books, the most famous of which is "Mammals of the Southern African Sub-region". This book is the standard reference on South African mammals and is unlikely ever to be surpassed. His last publication was a chapter on the *Giraffidae* in the just published Volume 2 of the prestigious "Handbook of World Mammals". Another guiding principle of his was that research output without concomitant production of post graduate students was a waste. During his career more than 100 PhD and Masters students enjoyed his attention and encouragement. Many of these have gone on to illustrious careers. Amongst these are Professor Rudi van Aarde, Africa's best known elephant scientist, and Professor Graham Kerley, Director of the Centre for African Conservation Ecology at Nelson Mandela Metropolitan University, Anthony Hall-Martin, formerly Deputy Director of SanParks, Dr Pat Condy, formerly Director of Conservation for the Johannesburg City Council and Malan Lindeque, Director-General of National Parks in Namibia.

He was President of the Royal Society of South Africa (and for many years edited its journal the *Transactions of the Royal Society of South Africa*) and President of the Zoological Society of South Africa. Internationally he was for ten years the Chairman of the Hyena Specialist Group of the International Union for the Conservation of Nature, a consultant to the Australian CSIRO and the Chinese and Russian Academies of Science, a scientific assessor for National Science Foundation (USA), National Environmental Research Council (UK), Leverhulme Trust

(UK) and the Alexander von Humboldt Foundation (Germany), a life Scientific Fellow of the Zoological Society of London, a life Fellow of the Institute of Biology, London, a Fellow of the Royal Society of South Africa and a life Member of the Zoological Society of South Africa and the Wildlife Management Association of South Africa. His distinction in research and research leadership was recognized by the award of the Gold Medal of the Zoological Society of South Africa, and the Senior Captain Scott Medal of the Biological Society of South Africa, and the Merit Award of the South African Association for the Advancement of Science. In retirement he was appointed Professor *Extraordinaire* at the Faculty of Veterinary Science in the University of Pretoria, where up until his death, he led the Centre for Veterinary Wildlife Studies. Earlier this year he was awarded a DSc *honoris causa* by the University of the Witwatersrand in recognition of his huge contribution to South African and International science in the fields of Zoology and Mammalogy. The citation noted that "no one has done more to bring zoology to the attention of the South African community, whether it be game farmers, agricultural extension officers, or the visitor to a national park, or to bring South African mammalogy to the attention of the international research community".

John Skinner worked tirelessly to promote young scientists, the disciplines of zoology and mammalogy, and South African science in general. He produced a cohort of distinguished protégés. His death marks the end of a remarkable career and it leaves a vacuum in zoology that will be difficult to fill.



## Interesting giraffe behaviour in Etosha National Park

Kerryn Carter, University of Queensland

In Etosha National Park, interesting giraffe behaviour was observed at the site of a dead giraffe, 3 weeks after it died.

The young adult female giraffe was found dead from unknown causes on 8<sup>th</sup> January, and a camera trap was placed at the carcass site to monitor scavenger activity. Carcass sites are monitored by camera traps in Etosha National Park as part of a long-running study about the anthrax virus that naturally occurs there.

Three weeks later, the camera trap captured a group of passing giraffe who showed a surprising amount of interest in the carcass site, even though the body had been removed by scavengers.

The first giraffe to show interest was an adult male, who bent down a number of times with splayed legs to sniff and scan the area where the carcass had been.

Next was a young female, followed by an older female, and then 3 giraffe inspected the area at once. The group was only captured at the site of the deceased giraffe for 13 minutes, but it is interesting that they all should find it so interesting.

Had they been there before and therefore knew that a giraffe had died there? Could they smell the giraffe that had previously been there? Was her scent familiar as an animal that they previously knew? But perhaps they were just looking for some bones to chew, as we see commonly in Etosha and other parts of Africa.

Whatever the reason, it reiterates the fact that there is still so much we don't know about these enigmatic animals.

Thank you to Steve Bellan from the University of California Berkeley for sharing the camera trap photos with the giraffe community.

### Contact:

Kerryn Carter

k.carter@uq.edu.au





## Kenya's reticulated giraffe are fighting an uphill battle!

Jamie Gaymer, Ol Jogi Ranch, Kenya

*"At the time I was actually pushing the animals out of Ol Jogi Reserve (Pyramid) into neighbouring Enasoit (to alleviate pressure on browse). Thereafter, the animals can migrate either east into Loldaiga or west into Ol Jogi Ranch. The giraffe are doing really well despite healthy numbers of predators and we were up to ~150 individuals on the 12,000 acre reserve alone - unfortunately I don't have numbers for the ranch but it is significantly more than that!!"*

*Anyway, the photo below shows a calf that the hyena's had obviously had a go at. I was tempted to intervene but decided to let nature take its course as the calf was still following its mum at the time. Amazingly, my rangers reported the little fellow a couple of days ago (2 months later) & the wounds seem to have healed. They are amazingly resilient!!"*



*"On another day I had noticed these 2 bulls had been having a go at each other through the fence for some time prior to the translocation. Anyway - when they got together it wasn't long before they were sorting out their differences. I left it a bit long but suspected that they needed to work out who was boss being that they would be sharing territory. The one bull was completely knocked out from an impact to the chest. Interestingly, the one on his feet tried clobber the other one as he lifted his head to stand up, obviously meant business. We chased the other bull off & he got back to his feet a couple of minutes later. I did notice that once up there were what appeared to be big hematomas on his shoulders where he had been whacked. I haven't monitored subsequent fighting*

*between the 2 bulls but the loser did have the ability to migrate to another property through a game corridor. Either which way, some pretty amazing photo's!!!"*



There is plenty of people 'watching' giraffe out there so if you have any interesting giraffe behaviour or action caught on film from across Africa please send them in to share with all in the next issue.

### Contact:

Jamie Gaymer  
warden@oljogild.com



## Necks for sex? No thank you, we're sauropod dinosaurs

Darren Naish

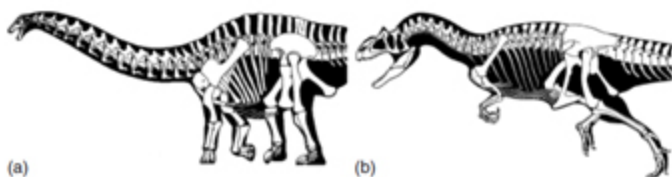
If asked "Why do giraffes have such long necks?", the majority of people - professional biologists among them - will answer that it's something to do with increasing vertical reach and hence feeding range. But while the 'increased vertical reach' or 'increased feeding envelope' hypothesis has always been the most popular explanation invoked to explain the giraffe's neck, it isn't the only one.



In 1996, Robert Simmons and Lue Scheepers argued that the giraffe neck functions as a sexual signal: they said that the necks of males are bigger and thicker than those of females, that the necks of males continue growing throughout life, that females prefer males with bigger necks, *and* that giraffe necks don't provide any obvious benefit in vertical reach or foraging range, contra the 'traditional', 'increased feeding envelope' hypothesis (Simmons & Scheepers 1996). This has become known as the 'necks for sex' hypothesis [obvious sexual dimorphism in giraffes (*Giraffa camelopardalis angolensis*/*G. angolensis*) shown above; image by Hans Hillewaert, from wikipedia].

### 'Necks for sex' visits the Mesozoic

It was only a matter of time before someone published the idea that the 'necks for sex' hypothesis might apply to another group of tetrapods famous for their long necks - namely, the sauropod dinosaurs.



In a well argued and extremely popular\* *Journal of Zoology* article, Phil Senter wondered whether sauropod necks might also have evolved under pressure from sexual selection, and not because of any ecological benefit that they might have incurred (Senter 2007) [the figure - from Senter (2007) - shows that *surprise!!* sauropods have long necks relative to theropods\*\*. The reconstructions are by Greg Paul]. Senter put forward six predictions that - if validated - would indicate the importance of sexual selection in the evolution of the sauropod neck, most of which related to the possibility of sexual dimorphism, the use of the neck in dominance or courtship displays, its redundancy as an adaptation for increased reach in feeding, and allometric increase in neck length across ontogeny and phylogeny. His conclusion was essentially that, yes, the sauropod neck likely evolved primarily under sexual selection pressure (Senter 2007).

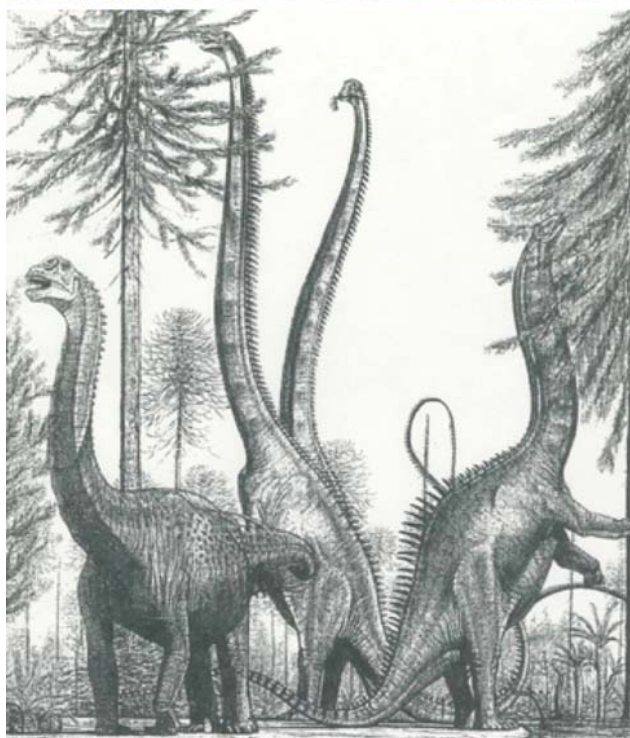
\* The Journal of Zoology website lists the article as one of the 'top 3 downloaded papers from 2007 and 2008'.

\*\* Senter (2007) actually used this diagram to show that "acetabular height is a good proxy for the height of the base of the neck in a sauropod and for the height of the mouth in a large theropod" (p. 47) (his implication being that the neck incurred a significant survival cost).

The montage below could be seen as a contrast between the two supposedly competing hypotheses. At top, we have some displaying *Sauroposeidons* (by Brian Engh of dontmesswithdinosaurs.com), perhaps imagined as per the 'necks for sex' hypothesis, while at bottom we have high-browsing Morrison Formation sauropods (by Greg Paul), imagined as per the 'increased feeding envelope' hypothesis.

Senter (2007) has been widely read and also cited in favourable contexts both in the dinosaur literature (Sander & Clauss 2008, Mateus *et al.* 2009, Siegwarth *et al.* 2010) and in the general literature on sexual selection (Swallow *et al.* 2009). Surprisingly, no one has said anything negative about it in print; I say that this is surprising because the data does not support Senter's predictions at all, and it's for this reason that I worked together with Mike P. Taylor, Dave Hone and Matt Wedel to produce a counter-argument (Taylor *et al.* 2011). These

three authors will be rather familiar names if you follow the palaeo-blogsphere... and that Naish guy, I think he blogs too.



Anyway, the fruit of our labours has just been released to the world (in digital form, anyway) in the online version of *Journal of Zoology* (Taylor *et al.* 2011). Given that this is where Senter's original article appeared, it seems obviously fitting that our response appear there too.

### When disagreements arise

Before I discuss our new paper further, one more bit of preamble. There are two perspectives on what to do when you encounter a published paper that you disagree with. Some people say that you should ignore the offending bit of research entirely and hope that it will simply sink into the morass of obscurity. This *can* work, since there are hundreds of academic articles out there

that are hardly read by anyone, are mostly un-cited, and just aren't influential enough to mislead future students. Furthermore, even an unfavourable citation is still a citation, and in today's world this apparently means something.

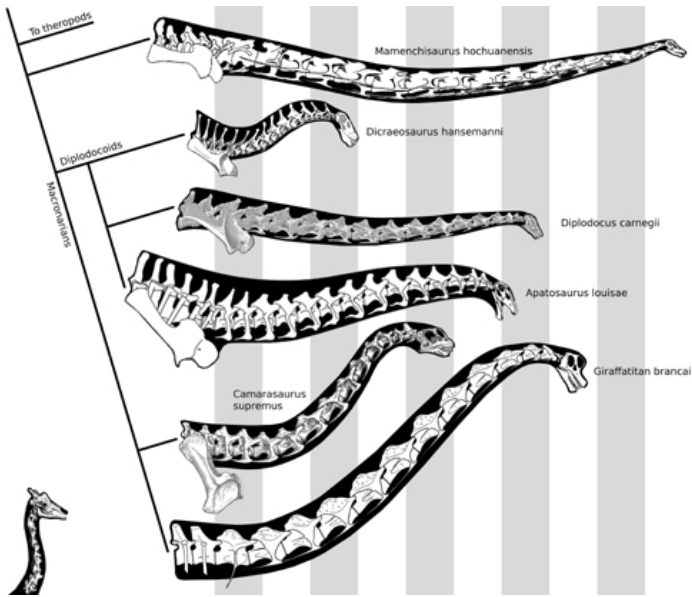
The second perspective is that researchers have a duty to use the peer-reviewed literature to correct errors and misinterpretations in the works of others. Naïve readers might otherwise see the offending published item, find that it's unchallenged, and then assume that it represents the state-of-play in the respective field. The result is that an erroneous or spurious claim can become widespread 'common knowledge', or even 'textbook dogma'. The following quote is relevant to so-called scientific creationism and most certainly not to Phil's 'necks for sex' paper, but it always sticks in my mind: "If knowledgeable people keep quiet, it only helps those who spread nonsense" (Aykut Kence, quoted in Koenig (2001)).

My perspective is that - if time and opportunity allows (*if*) - scientists should indeed take the time to respond appropriately to literature that they find fault with, otherwise it does become 'accepted'. Furthermore, I'm of the (possibly naïve) opinion that scientists have a moral obligation to engage with both their research community and human consciousness as a whole, not to simply work in isolation while pushing out their own cherished technical contributions. The fact that it took us about five years to respond to Phil's paper shows that we didn't - and, indeed, *couldn't* - prioritise our response (one reason for the delay is that we wanted to get the neck posture paper (Taylor *et al.* 2009) published first), but I hope you agree that we did the right thing in responding eventually (Taylor *et al.* 2011). Phil has been a complete gentleman about it and is pleased that his hypothesis has been critically examined.

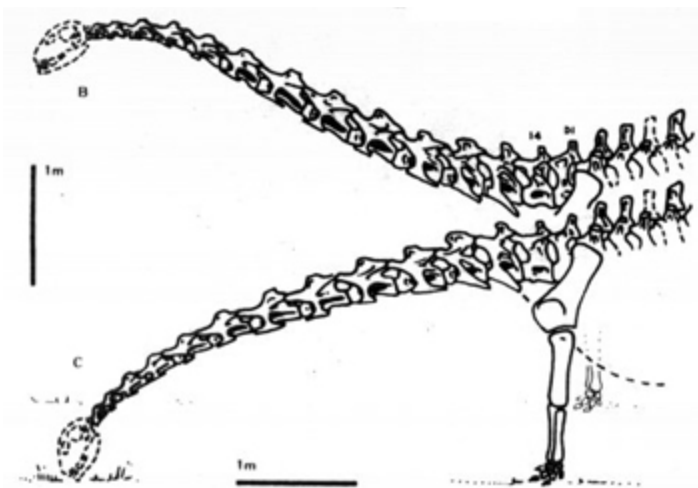
### The data we have does not support the 'necks for sex' hypothesis

Without discussing the ins and outs of the paper in entirety, we go through all of Phil's proposals and show either (1) that they don't support the sexual selection hypothesis, but are actually more consistent with the 'feeding envelope' hypothesis, (2) that they just can't be tested, because we don't have enough evidence, or (3) are equivocal, and aren't necessarily linked with sexual selection. [Diagram below, from Taylor *et al.* (2011), shows some of the variation in neck length present across

Sauropoda, mapped onto a phylogeny. The alternating vertical bands mark one-meter increments. That crappy little animal at bottom left is *Giraffa*].



So, we have no evidence whatsoever of sexual dimorphism in sauropod necks. We can't say anything about use of the sauropod neck in courtship or dominance. The presence of positive allometry in neck length is not - contra Senter (2007) - indicative of sexual selection since positive allometry occurs all over the shop in animal morphology, and positive allometry is far from ubiquitous in sexually selected features anyway (Taylor *et al.* 2011).

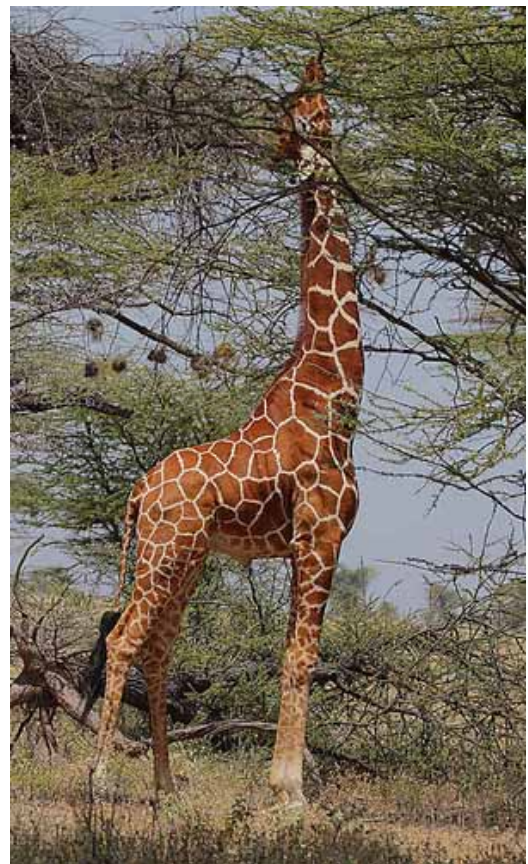


And while Senter (2007) argued that the long necks of sauropods didn't pose an obvious foraging benefit (he followed Martin (1987) and Stevens & Parrish (1999) in assuming that sauropod necks were mostly semi-horizontal), newer work (Taylor *et al.* 2009) has shown that the assumptions underlying these studies were in error. Even better, even if Martin (1987) and Stevens &

Parrish (1999) are correct, their conclusions are still consistent with the notion of an increased 'feeding envelope'. In fact, Martin (1987) very specifically framed his notion of subhorizontal-necked sauropods within the 'feeding envelope' hypothesis (one of John Martin's 'feeding envelope' diagrams is shown here).

### Giraffes and giant tortoises - together at last!

The backbone to Senter's 'necks for sex' idea comes from the hypothesis as originally formulated for giraffes (Simmons & Scheepers 1996). But in recent years it hasn't been doing all that well, and in fact has been widely questioned in the giraffe literature (Cameron & du Toit 2007, Mitchell *et al.* 2009, Simmons & Altwegg 2010, Van Sittert *et al.* 2010). In fact some authors (though - note - not all) would go as far as saying that it's been falsified. Regardless, most authors who specialise on giraffes have concluded that the 'increased feeding envelope' hypothesis is more likely to have been the main pressure affecting neck elongation in these animals [below image of high-browsing giraffe by Steve Garvie, from wikipedia].



So, to emphasise: the hypothesis that sexual selection was/is the *primary* selective mechanism acting on the giraffe neck has been found wanting (I wrote about this on Tet Zoo in February 2007). This work is recent, so naturally Senter (2007) couldn't and didn't cite it.

Incidentally, Senter (2007) was available in online form in August 2006; it's only the printed version that appeared in 2007. In the paper, we opted to recognise the date of digital publication - hey, Mike P. Taylor is first author - but, in this article, I've followed the citation as given on the Journal of Zoology website.

One problem that Senter (2007) could have addressed, however, is the implication throughout his paper that the 'feeding envelope' hypothesis is mutually inconsistent with the sexual selection hypothesis. In other words, that it's one or the other. As we argue in our paper, living animals show that dichotomies such as this are rare, with many/most structures being co-opted for more than one role (Taylor *et al.* 2011). This isn't just true for such sexually-selected organs as horns, antlers, tusks and so on, it's also definitely the case for long necks.



Giraffe necks are used in increasing foraging range, but they have a sociosexual role too. In our paper we draw special attention to long-necked Galápagos giant tortoises, partly because I continue to be frustrated by the fact that people ignore these long-necked, high-reaching browsers just about whenever they discuss long necks and high browsing. Work shows that Galápagos giant tortoises use the neck to increase feeding range, but they also use their vertical reach to intimidate other tortoises when fighting or establishing status (Fritts 1984) (as shown here: this image is redrawn from a photo and is not a hypothetical scene).

And mentioning Galápagos giant tortoises gave me the excuse to produce some fine, kick-ass pictures of tortoises doing battle, stomping iguanas, chasing off giant hawks... naah, kidding, I drew them feeding and staring at each other. People should definitely talk about Galápagos giant tortoises more whenever they consider long necks and high browsing. And it still seems all too poorly known that

even longer-necked giant tortoises existed until very recently: I'm referring to the *Cylindraspis* species of the Mascarenes. [life-sized model of Rodrigues saddle-backed tortoise *C. vosmaeri* shown below. Model created by Nick Bibby of Rungwe Kingdon and Claude Koenig's sculpture foundry Pangolin Editions].



Incidentally, we made a dreadful error that I don't think we'll ever live down... we spoke of Galápagos tortoises as if they belong to *Geochelone* whereas - as everyone knows - *Geochelone* of tradition is "rampantly polyphyletic" (Le *et al.* 2006). Consequently, Galápagos tortoises are nowadays classified within *Cheloidina* (Le *et al.* 2006). We also refer to the Galápagos giant tortoise taxa as if they're 'subspecies'. That arrangement is still preferred by some, but workers increasingly prefer to regard them as 'species' (e.g., Russello *et al.* 2010). I dropped the ball on this one and apologise profusely to my co-authors. That well known expert on testudine phylogeny and taxonomy, Thomas R. Holtz, jr., is warmly thanked for bringing all of this to our attention.

As I've said, the paper is actually rather complex and we went into an appropriate amount of detail in responding to Phil's original paper. That isn't because we're wordy writers; it's because the arguments involved are complex and there are various diversions and dead-ends that we needed to explore (I mostly haven't mentioned those here... *cough cough* blood pressure, mutual sexual selection *cough cough*). It must be said that we were able to formulate a clearly structured, (hopefully) easy-to-

follow argument because we followed the eloquent structure used beforehand in Senter (2007). We evidently don't agree with Phil's reasoning, but we admire the way he crafted his hypothesis.

It may not be well known outside of Mesozoic archosaur research, but a minor renaissance on sexual selection and the evolution of display structures is currently underway in the dinosaur and pterosaur literature. Our paper is merely the latest volley in what is turning out to be an increasingly interesting debate. To conclude, Taylor *et al.* (2011) show - pretty convincingly, we hope - that sexual selection was not (so far as we can tell) the primary pressure driving the remarkable elongate necks of sauropods, but this is far from the last word on the subject.

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#### Source:

[http://scienceblogs.com/tetrapodzoology/2011/05/no\\_necks\\_for\\_sex\\_in\\_sauropods.php?utm\\_source=sbhomepage&utm\\_medium=link&utm\\_content=channellink](http://scienceblogs.com/tetrapodzoology/2011/05/no_necks_for_sex_in_sauropods.php?utm_source=sbhomepage&utm_medium=link&utm_content=channellink)

#### Contact:

Darren Naish  
eotyranus@gmail.com

## Giraffe Indaba: Presentation Abstracts

Etosha Safari Lodge, Namibia, 4 – 7 July 2011

### Social associations and kinship in the Thornicroft's giraffe of Zambia

Fred B. Bercovitch & Philip S. M. Berry  
Primate Research Institute, Kyoto University,  
bercovitch@pri.kyoto-u.ac.jp

Giraffe society has been considered as both a loose aggregation of non-bonded individuals as well as a structured social network with a complex organization that is akin to the fission/fusion system found in species such as chimpanzees, African elephants, hyenas, and cetaceans. We analyzed 34 years of data (March 1972 to June 2006) collected from a population of Thornicroft's giraffe (*G. c. Thornicrofti* Lydekker 1911) resident in South Luangwa, Zambia in order to establish factors mediating both herd size and composition. Our sample consisted of 35 males and 15 females. Sex differences in herd formation were pronounced: cows were noted alone on only 8% of observations, while bulls were solitary on 67% of sightings. Excluding observations of singletons revealed an average herd size ( $\pm$  s.d.) of 5.2 ( $\pm$  3.6) individuals. Herd size was significantly larger during the wet than the dry season, and varied with ecozone. The largest herds were recorded in open areas, while the smallest herds were found in dense, thickets and shrubs. Herd composition was not random, with 24% of dyads in the region never found to associate with each other, while 11% of dyads had high levels of affiliation. Both kinship and sex of giraffe influenced herd composition. Female-female pairs were significantly more likely to be observed than were male-male or male-female dyads. Nearly one-third of possible male-male combinations were not noted in association with each other. Although kinship influenced herd composition, degree of relatedness did not. The highest social association index was documented among cows and their progeny, with no difference between sons and daughters. However, sister-sister dyads had stronger associations than did brother-sister dyads indicating that factors other than degree of relatedness influenced affiliation patterns. A comparison across species revealed that female-female giraffe dyads had tighter social associations with each other than did female-female hyenas and about the same level as male-male chimpanzees. We conclude that herd size reflects a

balance of foraging, antipredator, reproductive, and social strategies, while herd composition indicates that giraffe have an extensive social network within a fission/fusion society.

### Development and application of a computer-assisted system for photographic mark recapture analysis of giraffe populations

Douglas T. Bolger, Thomas A. Morrison, Derek E. Lee, Bennet Vance & Hany Farid  
Environmental Studies Program, Dartmouth College,  
dbolger@dartmouth.edu

Photographic mark-recapture is a cost-effective, non-invasive way to study populations. However, to efficiently apply photographic mark-recapture to large populations, computer software is needed for image manipulation and pattern matching. We created an open-source application for the storage, pattern extraction, and pattern-matching of digital images for the purposes of mark-recapture analysis. The resulting software package is a stand-alone, multi-platform application implemented in Java. Our program employs the SIFT operator (Scale Invariant Feature Transform) which extracts distinctive features invariant to image scale and rotation. We applied this system to a population of Masai giraffe (*Giraffa camelopardalis tippelskirchi*) in the Tarangire Ecosystem in northern Tanzania. Over 1200 images were acquired in the field during three primary sampling periods between September 2008 and December 2009. The pattern information in these images was extracted and matched resulting in capture histories for over 600 unique individuals. Estimated error rates of the matching system were low based on a subset of test images that were independently matched by eye. Encounter histories were subsequently analyzed with open population models to estimate survival rates and population sizes. This new open-access tool allowed photographic mark-recapture to be applied successfully to this relatively large population.

### Male Mating Strategies among the Giraffe of Etosha National Park

Rachel Brand

rachelanddanie@gmail.com

Among large herbivores, mating strategies of males are determined in large part by the feeding strategies and movement patterns of females. The Etosha population of giraffe (*Giraffa camelopardalis angolensis*) was studied over 18 months, and as described elsewhere, giraffe feeding strategies and habitat preferences were found to differ seasonally and between the sexes. Female distribution was clumped during certain times of year, leading to areas of high potential conflict between males for mates, and high potential for monopolization of females by breeding males.

Violent fights between males were generally avoided through the existence of clear dominance relationships and apparent reliance of visual assessment of competitors leading to displacement by the dominant individual. Darker-coloured males had a clear advantage in being able to displace paler, subordinate males, and females were more likely to be receptive to these darker, more dominant males. As such, these males' mating strategies appeared to involve a restricted-area searching tactic, resulting in smaller home ranges and a higher degree of association with females, especially in the rainy months. While immature males were tolerated by these dominant males, subordinate mature males were not, and consequently tended to have larger home ranges, a lower degree of association with females, and appeared to use a mating strategy that relies on chance encounters with undefended females in less-preferred habitats.

Thus it was evident that both scramble competition (mate detection) and 'priority of access' to mates were important in determining male mating opportunities. With this in mind, a surrogate index of probable individual male mating success is proposed using easily recordable socio-behavioural observations. When applied to the adult males in the study population, the index suggests a high degree of variation in probable reproductive success among mature males, and indicates that mating success may be highly skewed in favour of a small number of mature, dominant, very dark males.

### Preferred associations between female giraffe in Etosha National Park

Kerryn D. Carter

School of Biological Sciences, The University of Queensland, jakcat1@bigpond.com

The social organisation of a species is a vital component of its life history, yet social relationships are still poorly understood for many species. This project focuses on the social relationships among giraffe, which have previously been described as having little social structure nor strong bonds between individuals. Giraffe live in a society characterised by frequent changes of associates (termed fission-fusion societies) and, in older studies, these types of social structures may have been incorrectly portrayed as random associations. In this study, I investigated the association patterns of 180 wild female giraffe in Etosha National Park, Namibia by collecting 740 records of group composition between April 2009 and June 2010. Female giraffe showed a non-random social structure and the associations between some pairs of females were quite strong in comparison to other pairs within the population. This provides evidence that female giraffe do show preferred relationships in the wild. I will present information about the nature of these 'preferred' relationships in comparison to more 'casual' relationships found between females and discuss how seasonality, reproductive state or home range overlap may be factors that influence the strength of relationships in wild giraffe. This new information about giraffe social behaviour raises questions about how these preferred relationships may affect reproductive success and whether having close associates may improve individual survival and reproduction.

### Abundance and distribution of giraffe in northern Botswana

Michael J. Chase

Elephants Without Borders,  
info@elephantswithoutborders.org

A dry season (Sept- Oct 2010) fixed-wing aerial survey of giraffe (*Giraffa camelopardalis*) was conducted in northern Botswana to provide an updated status report on giraffe numbers and distribution, and assist with a historical analysis of giraffe abundance in northern Botswana. Most giraffe herds occurred in the southern

portions of the Okavango Delta. Average herd size was 3 (range 1 - 20). We estimated 5537 giraffe (377 herds) for the 73478-km<sup>2</sup> survey area (0.08 giraffe / km<sup>2</sup>). Based upon earlier aerial surveys (9) giraffe numbers have greatly reduced in northern Botswana from 12319 in 1996 to 5537 in 2010. Within the Okavango Delta the trend analysis suggests that giraffe have declined 8 % each year ( $P = 0003$ ). An analysis of rainfall and water flow data for the Okavango Delta, suggests this decline coincides with a 20 year drought cycle. Habitat fragmentation because of veterinary fences and human encroachment also appear to have affected giraffe abundance and distribution in northern Botswana, since 1996 when the first comprehensive aerial surveys were conducted.

### ExtractCompare: automated 3D pattern recognition

John Doherty, Lex Hiby, Robert Elwood & Michael Scantlebury

Reticulated Giraffe Project, Samburu National Reserve, johndoherty@sapiensnetwork.org

Reliable and repeated identification of individual animals within study populations has the potential to increase greatly the scope and resolution of research into behaviour, ecology and population dynamics. Giraffes are sufficiently different from one another in appearance to allow for individual identification without the need for invasive marking techniques. It is possible for researchers to become so familiar with their study animals as to recognise hundreds of individual giraffes on sight but this expertise takes time to acquire and is not easily transferable. Automated pattern-recognition avoids the need for such familiarity in the collection and processing of data on known individuals and a number of systems have recently been developed for use in research on giraffes. One of these systems, ExtractCompare, uses a three-dimensional model to process photographic data, allowing it to match images of the same individual taken from different angles and enabling researchers to make use of suboptimal material from a wide range of sources. In this introduction to ExtractCompare, its use is demonstrated with reference to the population of reticulated giraffes *Giraffa camelopardalis reticulata* endemic to the north and east of Kenya and its potential to contribute to the conservation of this and other endangered populations is discussed.

### Desert life – is it all about sun and sand?

Julian Fennessy

Giraffe Conservation Foundation & Namibia Nature Foundation, julian@giraffeconservation.org

The taxonomy, behaviour and ecology of desert-dwelling giraffe *Giraffa camelopardalis angolensis* in the northern Namib Desert was investigated over a 5-year period. This population resides at the extreme of the giraffe's range and no previous study has been published on its ecology.

The genetic architecture of Namibian giraffe when compared with genetic profiles of giraffe subspecies throughout Africa, indicate that the Namibian giraffe has five unique haplotypes and is genetically distinct from *G.c. giraffe* or any other extant subspecies.

A marked variation in population structure and dynamics (numbers, sex and age structure, herd structure and densities) between the three study areas possibly arose from differences in study area size, aridity, availability of forage and human impacts. Levels of associations between giraffe within the population using a simple ratio technique observed that increased association occurred in smaller populations; with a matrilineal social structure. In one bull-biased population, a higher degree of association between bulls was observed compared to bulls in the other two populations.

Using field-based monitoring and GPS satellite collars, giraffe's distribution and range in the northwest is one of the largest home ranges of any population in Africa (the largest for any bull) – correlating with low population density, reduced diversity of forage and, in bulls, increased search areas for receptive cows. Unexpectedly, giraffe movements occurred predominantly along riparian woodlands, although seasonal use of other habitats (plains, mountains) was observed.

Data from four GPS satellite-collared giraffe provided high-resolution data on daily movements, and indicated a pattern of highly biphasic movement behaviour that correlated with ambient temperatures. This data correlated with the most recorded diurnal activity budgets which indicated a variation between sexes, with cows spending more time feeding and resting, while bulls walked and ruminated more frequently. Juveniles rested more often than other giraffe. Seasonal variation in activity budgets was evident, perhaps reflecting use of an energy maximiser strategy for cows and an energy



minimiser strategy for bulls. The establishment of artificial water points in the Hoanib River during the study period appeared to alter the seeming independence of giraffe on water in the northern Namib Desert, and also resulted in small-scale shifts in use of the riparian woodland by elephant.

Seasonal changes in the abundance, moisture and protein content of available food plants correlated with shifts in the diet of giraffe. Giraffe impacted on their preferred forage source, *Faidherbia albida*, causing distinct structural changes in the individual plants and the *F. albida* population. This impact, combined with elephant damage and seasonal flood events, has resulted in a shift in the age structure and dynamics of the *F. albida* population over the past two decades.

#### **Feeding ecology of giraffe (*Giraffa camelopardalis*) in a fenced game reserve in North-Central Namibia**

**Katherine Forsythe & Laurie Marker**

Cheetah Conservation Fund,  
katherine.forsythe@gmail.com

Large herbivores can have significant impacts on the vegetation on which they feed. Understanding the interactions between large browsers and vegetation is especially important within small and enclosed systems, where browsing pressure is continuous. The feeding behaviour of a small group of 33 giraffe in a 3650 ha fenced game reserve in North-Central Namibia was studied in the late dry season. The tree species eaten were recorded during focal follows as well as tree height, distance between trees eaten, time per tree, group size and species of surrounding trees. Tree species preference was established using Jacob's Index characterising choices on a fine scale based on the relative abundance of near trees species while feeding, and on a broader scale using relative abundance of different species in the area. The giraffe were recorded eating six tree species dominated by the *Acacia* genus. Most commonly eaten species were *A. erioloba*, *A. reficiens* and *A. fleckii*. Most time was spent eating *A. erioloba*, *A. fleckii* and *A. mellifera*. Males browsed significantly taller trees than females. There was no difference in the average distance moved between trees or average time per tree between males and females. Average foraging group size was between 4 and 5 individuals. Preferences on a fine and broad scale were

not highly correlated. Giraffe showed no or some preference for the majority of species eaten, however, between 15-30% of the diet came from avoided species. Preferred species only accounted for 27% of the available vegetation. Preferences at either scale did not correlate with published results of condensed tannin contents; however, constant browsing could lead to higher induced levels in certain species, which would need to be quantified in this system. Selective browsing of less abundant, preferred species could also have significant effects on the vegetation structure of the reserve over time.

#### **A perfect match: how training giraffe in the captive environment enables institutions to partner with and support conservation work**

**Amy Phelps & Lisa Clifton-Bumpass**

Oakland Zoo, Oakland Zoo/International Association of Giraffe Care Professionals, APhelps@oaklandzoo.org

Conservation education is a critical element to the survival of wild species. This awareness creates a bond between humans and the animal populations that are at risk, increasing people's participation in fund raising and support of conservation work. Positive reinforcement based training programs are a powerful tool and an integral part of a modern and progressive captive giraffe management system and contribute to community education that shifts the public's interest from mild concern to activism. Giraffes that are active participants in strong conditioning and training programs become stronger ambassadors for their species by being more likely to engage guests in public-animal interaction opportunities, and generally being more visible and relaxed while on exhibit, thereby enhancing the zoo visitors' experience. Training also allows animal staff to put natural behaviours on cue, utilizing these behaviours in presentations for zoo visitors as part of a program to educate and inspire guests to care about the conservation issues facing giraffes today. Progressive training, management, and care programs help to ensure the sustainability of genetically healthy, viable captive populations, conditioning animals for shipment between facilities as well as training for semen collection and artificial insemination purposes, allowing optimal breeding pairings while minimizing stress, injury, and loss of animals. Furthermore, it enables staff to perform

medical procedures, thereby extending the life span and enhancing the quality of life for captive individuals. These methodologies also facilitate institutional participation in research and conservation projects that require biological samples and the study of captive giraffe behaviour, which may vary from that of its wild counterparts.

Inspired by the work of Ken Ramirez (Vice President of the Shedd Aquarium, Chicago, USA) addressing methods enabling training programs with marine mammals to support conservation, rehabilitation and re-release programs, this presentation will examine the opportunities that training programs present the captive and wild giraffe communities to join forces for the overall betterment of the species and advancement of giraffe conservation initiatives.

### REM-sleep as indicator for stress in giraffes (*Giraffa camelopardalis*)

Florian Sicks & Günther Fleissner

Tierpark Berlin, f.sicks@tierpark-berlin.de

Well balanced sleep is important for animals' well-being. Thus different studies have shown that sleep and activity patterns could be helpful in analyzing the well-being of animals. Furthermore, changes in the frequency or length of sleep could provide information about the ability of individuals to cope with changes in their environment. Especially the REM-sleep pattern seems to be important here, since it has been demonstrated in humans that REM-sleep increases at the beginning of infectious diseases or after traumatic events. Because of their peculiar sleeping position during the REM-sleep phases Giraffes are very well suited to analyze REM-sleep patterns in a non-invasive way via video observations.

Within my PhD-project it is being analyzed how the REM-sleep pattern changes after stressful situations. Therefore the sleeping behavior of giraffes is being observed before and after their transport to another zoo. In order to validate this new method, faeces samples are being analyzed with respect to the metabolite concentration of the stress hormone Cortisol. This has been done by a well established Enzyme-immunoassay that was tested with Giraffes for the first time now. Analyzing the sleep pattern of giraffe could give new insight in their biology and could support the *in* as well as *ex situ* conservation of these animals.

### Snare poaching in the Serengeti: implications for giraffe population dynamics

Megan Strauss & Morris Kilewo

University of Minnesota, strau102@umn.edu

The poaching of giraffes is becoming an increasing concern throughout Tanzania, and its occurrence in protected areas is particularly worrisome. In the Serengeti National Park in northern Tanzania preliminary evidence suggests that the giraffe population has suffered a substantial decline, with four- to seven-fold fewer giraffes now than in the mid 1970s. This occurred despite an increase in the potential food supply, raising the question of whether historical and or recent poaching has contributed to the reduction in giraffe numbers. Poachers in the Serengeti primarily use wire snares to entrap animals. Giraffes are sometimes targeted with snares suspended in the tree canopy yet the scale of giraffe poaching in the Serengeti remains unclear. Consumption data from villages adjacent to the Serengeti does not show giraffe to be a favoured or frequently consumed type of bushmeat relative to other species such as wildebeest. However, the large reduction in giraffe numbers is cause for concern. We set out to address the direct impact of snare poaching on giraffe population dynamics. We analysed a long-term dataset on snared wild animals collected by the Serengeti National Park (SENAPA) Veterinary Department. Our preliminary results are based on fourteen years of the SENAPA snare case data. We describe temporal and spatial patterns in snare cases, discuss the age and sex classes most affected by snare poaching and consider the implications of these findings. We hope to combine snare case findings with demographic models based on giraffe population structure to evaluate possible long-term effects of snare poaching on the dynamics of Serengeti giraffes. We feel this ecological approach is an essential complement to studies of bushmeat consumption and the socioeconomic drivers of poaching. We hope our results will guide management and conservation of the giraffe, the national symbol of Tanzania.

## Lion claw marks as an index of predation attempts on giraffes

Megan Strauss

University of Minnesota, strau102@umn.edu

Giraffes, particularly calves, are vulnerable to predation from lions. Even just the presence of lions can dramatically affect giraffe habitat use and behaviour. To advance our understanding of the complex relationship between the giraffe and its primary predator, I introduce an index of predation attempts: the lion claw mark index. This method involves examining the skin of live giraffes for visible lion claw marks, which can be easily distinguished from other scars or dermatological conditions. The claw mark index is promising as a supplemental method for studying giraffe-predator interactions because direct observations of predation events are infrequent and giraffe carcasses cannot always be linked to a cause of death. I applied the claw mark index to giraffes in three distinct study areas of the Serengeti National Park in northern Tanzania. I photographed the sides and rumps of hundreds of unique giraffes between 2008 and 2010. Claw marks were most often observed on the flank and rump but occasionally also on the neck and legs. My preliminary analysis shows that claw mark prevalence varies widely among the three study areas. Claw marks were rarely observed on calves or young subadult giraffes, suggesting that attacks on these age classes typically result in death and that this index is not a useful measure of lion predation attempts on young giraffes. For adult giraffes, on the other hand, claw mark prevalence in some areas was surprising, especially given the rarity with which lions are observed to attack giraffes in the Serengeti. While it is clear from my results that lions pose some risk to even the largest adult giraffes, additional work is needed to establish if and how the claw mark index relates to actual mortality rates for the adult age class. Future analyses will evaluate the relationship between claw mark presence and lion density, density of other prey species and other ecological and environmental variables.

## Long term survey of the endangered West African giraffe population (*Giraffa camelopardalis peralta*)

Jean-Patrick Suraud

University of Lyon, girafesduniger@gmail.com

Limited research has been undertaken on giraffe across Africa. The Niger government and IGWG identified that *G. c. peralta*, the most endangered giraffe in Africa, is a high conservation priority supported by the IUCN Species Survival Commission. The West African giraffe are genetically unique: a 2006 study showed the last of the *peralta* subspecies only reside in Niger. Additionally, a 2007 study strongly suggests that giraffe are not a single species (and nine subspecies) but at least six species. If this information were confirmed, the giraffe of Niger would likely be elevated to species level and critically endangered.

In 1996, the last 50 giraffes of West Africa were restricted to an area close to Niamey, Niger. They are a unique population in that they live outside of protected areas, have no natural predators, and co-habit with local people and their livestock. This provides an interesting model to better understand management of human/animal conflicts across West Africa.

From 2005 to 2008 an annual growth rate of approx. 12-13% was estimated from both annual count data and demographic parameters. This value fits with the maximum growth rate calculated for a browser species based on the allometric relationship linking growth rate and body mass. During the period 2005-2008 adult and sub-adult females had a constant survival rate of 0.94, and a constant recapture rate of 0.97. In order to have a better understanding of giraffe daily movement, 8 giraffes were equipped by satellite collars in 2010. First analysis showed important nocturnal movement and habitat selection different the day and the night. Giraffe tend to move closer to the villages at night, where tree density (resource) is higher.

Although the *peralta* has reached ~220 individuals in 2009, this unique population is increasingly threatened because of continued habitat destruction for fuel wood harvest, agricultural cropping and expanding pastoralism.

## Giraffe Indaba: Poster Abstracts

Etosha Safari Lodge, Namibia, 4 – 7 July 2011

### Male coat colouration as a signal of status in giraffe

Rachel Brand

rachelanddanie@gmail.com

The variation in giraffe pelage colouration and markings has previously been explored primarily in relation to taxonomy. However, the social significance of darker colouration in male giraffe had not been adequately addressed. The Etosha population of giraffe (*Giraffa camelopardalis angolensis*) was studied in order to elucidate the role that darker pelage colouration might play in male intra-sexual competition.

Using four coat colouration categories, males with darker-than-normal colouration (i.e. darker than that of adult females and sub-adult males) were significantly taller, and thus likely older, than those with normal or paler markings. A highly significant association between pelage colouration and type of agonistic interaction was found: only darker males were seen to be involved in intense necking fights, but never mild or moderate necking, and the majority of displacements involved at least one dark male. Coat colouration appeared to be a reliable indicator of male competitive ability, as outcomes of displacement interactions and necking fights were significantly biased in favour of the darker male. Furthermore, changes in male pelage pigmentation over the study period were generally associated with changes in social maturity and/or competitive ability.

A significant relationship was also found between coat colouration and the success of males in eliciting urination by females, demonstrating that pelage colour also plays a role in female mate choice. Despite frequent attempted sexual interactions between paler males and females, the majority of consortships involved darker males, as did all observed matings. Thus pelage colouration appears to function as a reliable signal of status, indicating social maturity, competitive ability, and probable reproductive success.

### The diet selection, habitat preferences and spatial ecology of re-introduced giraffes (*Giraffa camelopardalis*) in the Kgalagadi Transfrontier Park

F. Deacon & G.N Smit

Department of Animal, Wildlife and Grassland Sciences, University of the Free State, deaconf@ufs.ac.za

Relocation of herbivore game species such as giraffe to areas in which there is limited information as to their adaptation success or potential impact on the environment, requires careful consideration. If relocation is implemented, thorough planning and subsequent monitoring will be required. It also presents opportunities for research and such an opportunity presented itself when SANParks approved the relocation of a number of giraffe from a well established population in the Auob riverbed of the Kgalagadi Transfrontier Park in the Northern Cape of South Africa to a remote part of the northern Nossob riverbed of the park. The main difference between the two ecosystems is the absence of *Acacia haematoxylon* in the Nossob riverbed, which is the key food species of giraffe in the Auob riverbed. The decision to relocate some of the giraffe was motivated by the increased impact of a growing giraffe population on *A. haematoxylon* and thus the need to reduce the population.

The objectives of the study are to: (i) assess the adaptation of the translocated giraffe to an environment without *A. haematoxylon*, and (ii) monitor the impact of the giraffe on other potential food plants such as *A. erioloba*, *A. luederitzii* and *Boscia albitrunca*. The proposed research will focus on the seasonal movements and diet selection of the relocated giraffes in relation to a GIS based resource map in which aspects such as vegetation types, plant phytomass (browse) and location of watering points will be incorporated.

Proposed methods include determining the spatial ecology and home range of the giraffe by equipping animals with specially developed GPS collars for up to 2 years. ArcMap (GIS) will be used for the display and analysis of the spatial distribution of the giraffe and to identify feeding stations and food preferences. Surveys of the tree layer will be done within survey plots stratified

around waterholes with belt transects dimensions of 100 x 2.5 m (250 m<sup>2</sup>). The species composition, dry matter production and structure of all rooted, live trees will be measured in accordance with the BECVOL-model (Biomass Estimates from Canopy Volume) which is based on the quantitative description technique.

### Reticulated Giraffe Project

**John Doherty**, Robert Elwood & Michael Scantlebury  
Samburu National Reserve,  
johndoherty@sapiensnetwork.org

Reticulated giraffes *Giraffa camelopardalis reticulata* are endemic to the north and east of Kenya, where their occurrence remains relatively natural. Although their distribution is now restricted largely to conservancies, parks and reserves, many of these protected areas are unenclosed and there have been relatively few translocations between them. Against a background of falling giraffe numbers across Africa, however, reticulated giraffes are thought to have suffered an especially steep population decline from perhaps 28,000 in 1998 to between 3,000 and 5,000 today. The primary cause is likely to be an increase in rates of mortality, a result especially of poaching and that especially for meat: out with the protected areas, the remaining range of reticulated giraffes is characterised by growing human populations, by refugees from local and regional conflicts, by environmental degradation and poverty, by overstretched security forces and by a widespread availability of automatic weapons. The Reticulated Giraffe Project is an initiative of Queen's University Belfast. It aims to address the recent population decline through a combination of research into reticulated giraffes' behaviour, ecology and population dynamics with awareness generation, environmental education and the provision to policy makers and stakeholders of reliable information and advice.

### Management of extra-limital giraffe (*Giraffa camelopardalis giraffa*) in Mosaic Thicket in South Africa

**Andri Marais**, Laurence Watson & Anton Schmidt  
andri.cornelius@gmail.com

In this study, certain management aspects of extra-limital giraffe in the Mosaic Thicket of the southern Cape in South Africa were explored. This included diet composition and preference and the ecological browsing capacity of Mosaic Thicket for giraffe. Diet composition was determined by direct observations throughout the year and the strength-of-preference index was used to calculate dietary preference indices. Although the recorded diet consisted of 22 browse species, only two species, *Acacia karroo* and *Acacia cyclops*, formed the bulk of their diet throughout the year. A definite seasonal dietary shift was evident. *A. karroo* was favoured in summer and autumn and formed the main food species in spring, summer and autumn. *A. cyclops*, an alien invasive species, was favoured throughout the study, but its contribution to the diet increased during winter when less *A. karroo* was consumed. This seasonal shift is related to the deciduous nature of *A. karroo*. Unexpectedly, the contribution to the diet of *Grewia occidentalis*, which was favoured by giraffe throughout all seasons, remained low. However, a browsing impact survey indicated that this species was heavily utilized by the entire browsing guild on the estate, making it relatively unavailable to giraffe. The ecological browsing capacity for giraffe in Mosaic Thicket, based on a quantitative assessment, was estimated to be between 0.020 BU/ha and 0.095 BU/ha. Depending on the available phytomass of plant species that formed the bulk of the giraffe diet at between 2 to 5 m above ground (i.e. preferred giraffe feeding height), an ecological capacity of 0.063 BU/ha or 0.016 giraffe/ha is proposed although not considered a long-term stable estimate for the region. At best it is only a first approximation of giraffe browsing capacity and provides decision makers with a starting point on which to base initial giraffe stocking rates. Continuous adaptive management focusing on herbaceous composition, available phytomass and the condition of key browse species, is highly recommended.

### The giraffes in the Katavi National Park, Tanzania—Social preference for group formation and for social behaviours

Miho Saito & Gen'ichildani

Kyoto University, nairobi3dogs@yahoo.co.jp

Giraffe social organization is described as a non-territorial, loose association of individuals. However it has been reported that mother-daughter pairs and some pairs of adult females have continuous social relationships. In addition, giraffe are reported to have crèche. It is possible that the composition of crèches is based on social preferences among specific individuals, but this pattern has not been examined in depth. Most studies about social preferences or social interactions in giraffe have been conducted in captivity and few studies with individual identification have been undertaken in the wild. The aim of this study is to reveal giraffe's, especially calves' and juveniles', social preferences for group formation and to examine how social behaviours change with developmental stage. Fieldwork was carried out during July and November, 2010 in Katavi National Park, western Tanzania. Data were collected using direct observations, usually on foot from close range. When a herd of giraffes was detected, each giraffe's sex and the herd size were recorded. Age of each individual was estimated on the basis of its body size, with pelage pattern of the neck also recorded for individual identification. In addition, social behaviours were scored as grooming, head rubbing, suckling, and anogenital examination. Twenty bulls, 21 cows, 12 juveniles, and 6 calves were identified during this study period. The most frequently observed pairs that were observed were cow-calf pairs and cow-juvenile pairs. We assume that these pairs were mothers and offspring, and thus suggest that the bonding between mother-offspring is tight and long-lasting. Pairs of calves and pairs of juveniles were less often observed than pairs of calf-bull and juvenile-bull. Pairs of specific females were also observed on different days. Thus, cows seem to have social preferences for association in the wild. Calves most frequently directed social behaviours to similar-aged peers, but not as often to cows. There were few social behaviours among cows. These results suggest that the giraffe's social preference for group formation does not always accord with that for directing social behaviours.

### Using camera traps to investigate drinking patterns in giraffe (*Giraffa camelopardalis angolensis*) on Ongava Game Reserve, Namibia

Ken Stratford & Sabina Stratford

Ongava Research Centre, ks@ongava.com

Ongava Game Reserve is located in the semi-arid region of northern Namibia, adjacent to Etosha National Park. In the dry season, once the ephemeral and standing dams have dried out, giraffe drink at artificial waterholes distributed across the property. We are using camera traps deployed at these waterholes and recognition of individuals to investigate three aspects of drinking behaviour. First we analyse the parameters of all drinking events and relate those to the individual as well as the timing and location of the event. Secondly, by placing camera traps at all waterholes, we analyse spatial patterns of waterhole use by individuals to assess any preference for waterhole location or type. Finally, we use 12-month continuous camera trapping data sets from selected waterholes to examine seasonal variation in use.

In this preliminary analysis we present data from one long-term monitoring waterhole as well as two 2-week survey periods covering all eastern and western waterholes respectively. Our camera traps are configured to take sequences of 10 images once triggered – a giraffe drinking typically triggers a series of such sequences (10-650 images). From over 86,000 images we extracted 572 independent observations. We found a significant difference between drinking times at waterholes close to human habitation (peak 23h00-01h00) when compared to remote waterholes (peak 13h00-15h00).

We then analysed a sub-set of 366 drinking events in which left-side images of individuals drinking that were of ID-quality were available. We were able to make a positive identification in all instances, resulting in 144 unique individuals (60% male; 40% female). On average, males made more drinking visits than females (males 3.0; females 1.8). The remaining drinking events with right-side images have not yet been included in this analysis.

For the year 2010, we recorded 200 giraffe drinking events at the long-term monitoring waterhole. These resolved to 58 different individuals, 28 of which (48%) were only recorded once. During the 2-week survey periods when ten of the eleven waterholes were monitored (140 effective trap nights in two batches), we

recorded 123 drinking events across 90 individuals. Most (67; 74%) individuals were recorded only once. Three of the 90 individuals were recorded at more than one waterhole in these survey periods. Taken together, these preliminary findings suggest that giraffe in the semi-arid habitat on Ongava do not drink at waterholes in regular patterns, but however display strong spatial preferences.

### Conservation status of giraffe in Africa

**Andy Tutchings & Julian Fennessy**

Giraffe Conservation Foundation,  
andy@giraffeconservation.org,  
julian@giraffeconservation.org

Are giraffe truly Africa's forgotten megafauna? The taxonomic status of giraffe is poorly understood to say the least and there is an urgent need of a review, using current genetic and morphological know-how, to provide a solid scientific baseline. Coupled with these unknowns is the knowledge that giraffe numbers are plummeting across their range and their distribution is shrinking rapidly – along with many other species on the continent. Various threats to giraffe are obvious, from predators to disease, but their social importance in some areas of Africa is little understood and requires long term study. In general, limited research has focussed on the plight of giraffe in Africa, let alone any long-term ecological (or other) research on a population(s) - as such our understanding of their life history, taxonomy and social importance is poor.

Over the last five years research has led to the Red Listing of two giraffe (sub)species as endangered, with evidence

indicating others are likely to endure a similar fate. Involvement and integration of giraffe research into actions of government, NGO, private sector and individuals is critical to supporting the long-term conservation of Africa's forgotten megafauna.

Are giraffe truly Africa's forgotten megafauna? The taxonomic status of giraffe is poorly understood to say the least, and there is an urgent need of a review, using current genetic and morphological know-how, to provide a solid scientific baseline. Combined with this unknown is the evidence that giraffe numbers are plummeting across their range and their distribution is shrinking rapidly – along with many other species on the continent. Various threats to giraffe are obvious, from predators to disease, but their social importance in some areas of Africa is little understood and requires long term study. Limited research has conducted on the plight of the wild giraffe, let alone any long-term ecological (or other) research on any of the population(s), especially when considered relatively in comparison to the levels of research carried out on all other major African megafauna. As such our understanding of their life history, taxonomy and social importance is at best poor.

Research over the last five years has led to the Red Listing of two giraffe (sub)species as endangered, with evidence indicating others are likely to endure a similar fate. Involvement and integration of giraffe research into actions of government, NGO, private sector and individuals is critical to supporting the long-term conservation of Africa's forgotten megafauna.

### Giraffe Digital Library

As one of its many on-going projects, GCF has recently started to compile a comprehensive digital giraffe library. The long-term vision is to make all publications freely available on the GCF website, but in the interim a bibliography can be requested and as well as papers. To date the digital library includes more than 120 scientific and popular papers from the wild and captive giraffe world.

We would like to encourage all of you to contribute to this digital library and also make use of it! Please contact Steph Fennessy (GCF Executive Officer, [steph@giraffeconservation.org](mailto:steph@giraffeconservation.org)) to obtain a copy of the bibliography to date and to see whether you can help add to this worthwhile project by forwarding digital copies of additional papers.



## Recently published research

**Doube M, Kłosowski MM, Wiktorowicz-Conroy AM, Hutchinson JR and Shefelbine SJ. 2011. Trabecular bone scales allometrically in mammals and birds. *Proceedings of the Royal Society B*. 278: 1721 3067-3073.**

Many bones are supported internally by a latticework of trabeculae. Scaling of whole bone length and diameter has been extensively investigated, but scaling of the trabecular network is not well characterized. We analysed trabecular geometry in the femora of 90 terrestrial mammalian and avian species with body masses ranging from 3g to 3400kg. We found that bone volume fraction does not scale substantially with animal size, while trabeculae in larger animals' femora are thicker, further apart and fewer per unit volume than in smaller animals. Finite element modelling indicates that trabecular scaling does not alter the bulk stiffness of trabecular bone, but does alter strain within trabeculae under equal applied loads. Allometry of bone's trabecular tissue may contribute to the skeleton's ability to withstand load, without incurring the physiological or mechanical costs of increasing bone mass.

**Taylor MP and Wedel MJ. 2011. Why giraffes have such short necks. Conference paper: *The Annual Symposium of Vertebrate Palaeontology and Comparative Anatomy 2011*. Oxford, UK.**

The necks of sauropod dinosaurs were by far the longest of any animals, exceeding 15m. Four clades with very different cervical morphologies (mamenchisaurids, diplodocids, brachiosaurids, and titanosaurians) evolved 10m necks. By contrast, the neck of the giraffe, the longest of any extant animal, reaches only 2.4m. Those of theropods and pterosaurs attained at most 3m. (Even among aquatic animals, the record is only 7m for elasmosaurs.) Four factors contributed to sauropod neck length: the sheer size of the animals, their distinctive vertebral architecture, air-sacs, and heads that merely gathered food without processing it. Cervical vertebral innovations included: extreme pneumatisation, which lightened the neck and increased bending resistance; elongate cervical ribs, which allowed hypaxial muscles to shift posteriorly; and, in several clades, bifid neural spines, which aided stability by shifting epaxial tension elements laterally. Bifid cervicals evolved at least four times among

sauropods and were never secondarily lost; they are otherwise found only in Rhea. However, other aspects of sauropod cervical anatomy remain puzzling: low neural spines reduced the moment arm of epaxial tension members; ventrally displaced cervical ribs increased bulk; and epiphyses were not posteriorly elongated. These apparent flaws suggest our understanding of sauropod neck mechanics remains incomplete.

**Badlangana NL, Adams JW and Manger PR. 2011. A comparative assessment of the size of the frontal air sinus in the giraffe (*Giraffa camelopardalis*). *Anatomical record*. 294(6):931-40.**

The current study examines the frontal air sinus of the giraffe (*Giraffa camelopardalis*) cranium with the aim of evaluating previously offered hypotheses as to why they have such an atypically voluminous frontal sinus relative to other artiodactyls. To date, no quantification of the frontal sinus in the adult or developing giraffe has been undertaken or compared to other artiodactyl species. Crania from eight species of adult artiodactyls, and giraffes varying in age from newborn to adult, were studied using CT scans to provide a volumetric assessment of the frontal sinus. Sinus volume was strongly correlated to cranial mass in the male giraffe ontogenetic series. The adult giraffe of both sexes were found to possess a far larger than predicted sinus volume relative to the relationship between frontal sinus volume and cranial mass observed in the other adult artiodactyls. Our results suggest that the volume of the frontal sinus in the giraffe is likely to be unique among artiodactyls, and the potential function and evolution we consider in light of several previously articulated hypotheses.

**Sathar F, Badlangana NL and Manger PR. 2010. Variations in the thickness and composition of the skin of the giraffe. *Anatomical record*. 293(9):1615-27.**

This study examined the skin of two 1- to 2-year-old male giraffes and one adult male, determining skin thickness and histological structure with reference to it functioning as a component of the features required for the maintenance of blood pressure, dermal armor, or thermoregulation. It has been argued that a tight skin surrounding the extremities of the giraffe aids in the movement of fluid against gravity, hence preventing



pooling of blood and tissue fluid (edema), but the skin has also been implicated in the thermoregulatory capacities and defensive anatomy of many mammalian species. In one of the younger giraffes, one-half of the skin was analyzed from which close to 170 sites were measured. In the other young and adult giraffes, spot tests to confirm the pattern observed in the fully analyzed individual were undertaken. It was discovered that the skin varied in thickness across the entire body and within regions of the body. Histological evaluation revealed that the skin was mostly collagenous, although interesting patterns of elastic fiber densities were also apparent. The skin in the neck and legs exhibited a morphology that may assist in cardiovascular regulation of blood flow to and from the head and legs, and the skin of the trunk and anterior neck has the possibility of functioning in a protective role. The analyses performed could not add any new data regarding the thermoregulatory role already described for giraffe skin.

**Bux F, Bhagwandin A, Fuxe K and Manger PR. 2010. Organization of cholinergic, putative catecholaminergic and serotonergic nuclei in the diencephalon, midbrain and pons of sub-adult male giraffes. Journal of chemical neuroanatomy. 39(3):189-203.**

The current study describes the nuclear organization and neuronal morphology of the cholinergic, putative catecholaminergic and serotonergic systems within the diencephalon, midbrain and pons of the giraffe using immunohistochemistry for choline acetyltransferase, tyrosine hydroxylase and serotonin. The giraffe has a unique phenotype (the long neck), a large brain (over 500 g) and is a non-domesticated animal, while previous studies examining the brains of other Artiodactyls have all been undertaken on domesticated animals. The aim of the present study was to investigate possible differences in the nuclear organization and neuronal morphology of the above-mentioned systems compared to that seen in other Artiodactyls and mammals. The nuclear organization of all three systems within the giraffe brain was similar to that of other Artiodactyls. Some features of interest were noted for the giraffe and in comparison to other mammals studied. The cholinergic neuronal somata of the laterodorsal tegmental nucleus were slightly larger than those of the pedunclopontine tegmental nucleus, a feature not described in other mammals. The putative

catecholaminergic system of the giraffe appeared to lack an A15 dorsal nucleus, which is commonly seen in other mammals but absent in the Artiodactyls, had a large and expanded substantia nigra pars reticulata (A9 ventral), a small diffuse portion of the locus coeruleus (A6d), an expansive subcoeruleus (A7sc and A7d), and lacked the A4 nucleus of the locus coeruleus complex. The nuclear organization of the serotonergic system of the giraffe was identical to that seen in all other eutherian mammals studied to date. These observations in the giraffe demonstrate that despite significant changes in life history, phenotype, brain size and time of divergence, species within the same order show the same nuclear organization of the systems investigated.

**Badlangana NL, Bhagwandin A, Fuxe K and Manger PR. 2007. Distribution and morphology of putative catecholaminergic and serotonergic neurons in the medulla oblongata of a sub-adult giraffe, Giraffa camelopardalis. Journal of chemical neuroanatomy. 34(3-4):69-79.**

The current study details the nuclear parcellation and appearance of putative catecholaminergic and serotonergic neurons within the medulla oblongata of a sub-adult giraffe, using immunohistochemistry for tyrosine hydroxylase and serotonin. We hypothesized that the unusual phenotype of the giraffe, this being the long neck and potential axonal lengthening of these neurons, may pose specific problems in terms of the efficient functioning of these systems, as several groups of catecholaminergic and serotonergic neurons, especially of the medulla, are known to project to the entire spinal cord. This specific challenge may lead to observable differences in the nuclear parcellation and morphology of these systems in the giraffe. Our personal observations in the giraffe reveal that, as with other Artiodactyls, the spinal cord extends to the caudal end of the sacral vertebrae. Within the giraffe medulla we found evidence for five putative catecholaminergic (neurons containing tyrosine hydroxylase) and five serotonergic nuclei. In terms of both morphological appearance of the neurons and nuclear parcellation we did not find any evidence for features that may be considered affected by the phenotype of the giraffe. The nuclear parcellation and appearance of both the putative catecholaminergic and serotonergic systems in the medulla of the giraffe studied

are strikingly similar to that seen in previous studies of other Artiodactyls. We interpret these findings in terms of a growing literature detailing order specific phylogenetic constraints in the evolution of these neuromodulatory systems.

**Badlangana NL, Bhagwandin A, Fuxe K and Manger PR. 2007. Observations on the giraffe central nervous system related to the corticospinal tract, motor cortex and spinal cord: what difference does a long neck make? Neuroscience. 148(2):522-34.**

The mammalian corticospinal tract is known to contain axons that travel from the cerebral cortex to various levels of the spinal cord and its main function is thought to be the mediation of voluntary movement. The current study describes neuroanatomy related to the corticospinal tract of the giraffe. This animal presents a specific morphology that may present challenges to this neural pathway in terms of the metabolism required for correct functioning and maintenance of potentially very long axons. The spinal cord of the giraffe can be up to 2.6 m long and forms the conus medullaris at the level of the sacral vertebrae. Primary motor cortex was found in a location typical of that of other ungulates, and the cytoarchitectonic appearance of this cortical area was similar to that previously reported for sheep, despite the potential distance that the axons emanating from the layer 5 gigantopyramidal neurons must travel. A typically mammalian dorsal striatopallidal complex was transected by a strongly coalesced internal capsule passing through to the pons and forming clearly identifiable but somewhat flattened (in a dorsoventral plane) pyramidal tracts. These tracts terminated in a spinal cord that exhibited no unique anatomical features related to its length. Our results, at least at the level of organization investigated herein, show that the corticospinal tract of the giraffe resembled that of a typical ungulate.

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