

**CROCODILE
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COVER PHOTOGRAPH: New Guinea Freshwater Crocodile,
Crocodylus novaeguineae. Photograph: Jack Cox.

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Yee Tai Leather Enterprise Ltd., Hong Kong.

Editorial

The CSG Student Research Assistance Scheme continues to grow, with a further 6 grants approved: Gisela Poletta (Argentina), Lizette Bekker (South Africa), Rheyda Hinlo (Phillipines), Mike Vandewedge (USA), Roberta Rocha da Silva Leite and Ricardo Freitas Filho (Brazil). This brings the total to 15 grants to date, which means 15 post-graduate students doing research on crocodilians rather than other species.

CSG has commenced the morphometric project in Colombia, in collaboration with Colombian farmers and researchers. Matt Brien (WMI) completed the first set of measurements on 245 *Caiman crocodilus fuscus* in June. The aim is to provide an objective method of predicting the size of crocodile from skins, flanks or even products. Colombia imposes a maximum size limit on exported skins, and has requested the Parties to CITES to assist them in detecting illegal trade. The results of the morphometric study will assist that process.

California Senate Bill 609, extending the sunset clause on the sale of crocodilian products in California through to 2015, received a majority vote of the full Assembly and now moves to the Governor for enactment. This is a truly remarkable effort of real conservation significance, not just in the USA but around the world. My personal congratulations to all involved, particularly Don and Pam Ashley.

The Gharial Conservation Alliance (GCA) held a Gharial Pre-

Species Recovery Planning Workshop at the Vishwa Yuvak Kendra (Youth) Hostel, New Delhi, India, on 22-24 June 2009. Some 24 people participated in the workshop, including representatives from Government, NGOs, researchers, GCA and the CSG. Tom Dacey attended and Perran Ross facilitated with assistance of Ravi Chellam (WCS-India).

Samuel Martin and Christine Lippai attended a preliminary meeting in Ouagadougou, Burkina Faso, to discuss logistics and arrangements for the 2nd CSG West Africa Sub-regional meeting, scheduled to be held in Nazinga Game Ranch, Burkina Faso, 23-27 November 2009.

Work on the proposed update of the CSG Status, Survey and Conservation Action Plan is moving, but slowly. Authors of the outstanding species accounts are requested to get their information to Colin Stevenson or the Executive Officer as a matter of urgency.

Members may have experienced some recent difficulties with accessing the CSG website. This was occasioned with the return of Akira Matsuda to Japan after spending 3 years in Australia. The website has been updated and is now back on line.

The Executive Officer sent out annual letters of requests to CSG donors, whose support to the CSG is critical to its ability to operate, particularly in these difficult economic times. I am personally very grateful to everyone who has made a contribution, past and present. The CSG remains an active and innovated group of volunteers, who do a great deal to assist the conservation, management and sustainable use of world crocodilians.

The 58th meeting of the CITES Standing Committee will be held in Geneva, Switzerland, on 6-10 July 2009. The following items of interest to the CSG are on the agenda: (a) Illegal trade in *C. niloticus* from Madagascar; (b) Trade in crocodilian specimens (control and marking); and (c) Personal and household effects. Several CSG members will be in attendance, including Christine Lippai, Hank Jenkins and Don Ashley.

The proposed Sabah HCC Workshop to be held in Kota Kinabalu, Sabah, Malaysia, has now been re-scheduled to early 2010. For further information please contact Silvester Saimin, Sabah Wildlife Department (slyluki@hotmail.com).

I am also proposing to hold a strategic CSG Executive Meeting in Darwin, Australia, in mid-October 2009. The last one was held immediately before the Bolivia working meeting and it proved very valuable indeed. It was a chance to discuss and review the strengths and weaknesses of crocodile conservation around the world. In the long-term, we need to ensure the CSG itself is economically sustainable. Through the Executive Officer, I will seek the views of senior members of the CSG Steering Committee before we meet, but any CSG members are entitled through Tom to raise issues they feel should be addressed by the Executive.

Professor Grahame Webb, CSG Chairman.

Recession-proof Conservation: Is This Bear Market a Crocodile Fiesta or a Firing Squad?

How can we expect this global financial crisis to affect the crocodilian leather industry and conservation?

Is it time to be gloomy about the fate of the crocodilian industry, and should CSG be worried about its attendant conservation impact? When researching the crocodilian leather industry, we often hear tales of the resilience of crocodilian products in the face of numerous limitations and challenges. Indeed, clever economists often assert that luxury goods buck the trend in bear markets. Along the crocodilian leather supply chain there are currently hints that this resilience persists. If we accept resilience at the top end, what does this mean for the rest of the market? And what does all this mean for conservation, and the CSG's role in 2009?

1. Missing link?

The recession, through its impacts on credit and income, approximates a natural laboratory. This paper is an initial stab at putting some ideas out there for discussion on how CSG can use the current economic environment to better understand and react and inform its members on how best to work together to ensure that restrictions in credit markets don't gnaw at conservation of wild populations through perverse incentives in the supply chain for leather goods. It can also help us to better understand the drivers of crocodilian trade and how conservation policy can be more effective.

2. Industry profile - how integrated are these markets?

Crucial to drawing a link between demand, prices and supply and costs are our assumptions over how different markets operate together as complementary or competitive forces. Broadly:

- Luxury wags the tail (through "aspiration"): Luxury leads, everything else follows (this assumption lies at the core of understanding the fashion industry for most analysts, which sees 'regular' fashion following the lead of high-value luxury brands. These luxury brands inspire imitation among all less-well-heeled members of society through advertising and celebrity associations). Hence the industry is strongly connected across market sector; healthy luxury product offer/sales can help secure the rest of the industry.
- Money decides (through desperation): Disposable income is the crucial factor. Hence, the industry is weakly connected across industry sectors; price and pocket wealth define each market segments' health independently, from luxury to shopping mall to market stall.

3. Chewing over the retail industry gossip in the recession

Crocodilian leather goods span a large swathe of products and market segments from backpackers buying locally produced wallets at cheap roadside market stalls in Range

States, to businessmen buying \$3000 handbags in Parisian boutiques. Yet, crocodilian leather products remain relatively luxurious in each market segment, being at the upper reaches of the value proposition on like-for-like products in its price range. Otherwise the profiles differ among segments in supply, demand, retail location, etc.

a. Luxury sector

It is clear that overall in the luxury retail segment there is optimism in the face of crisis. Yet, there are winners and losers. But price is not the turnkey to higher sales. Luxury sector rarely discounts the price of its products. 2 "Discounting is the antithesis of a luxury brand," said Francesco Trapani (CEO of Bulgari) adding that "this isn't a business where you reduce prices to sell more" (IHT 2008; FREEP 2008).

The wealthy are still shopping. The wealthiest, those worth over \$30 million, "are not facing a personal liquidity crisis and expect to spend as much or more this holiday season than they did last year" say Prince & Associates - a private-wealth researcher that surveyed 518 people, each of whom own at least one jet.

Stealth wealth, discreet luxury, shhh-opping, inconspicuous consumption, are all being spoken about in marketing circles as new phenomenon, as customers opt for understated luxury and classic design (SABR 2008; NYO 2008; NYT 2008b, 2009; Reuters 2009a; FD 2008).

However, there are competing stories. Emerging markets are up - upbeat Merrill Lynch expects sales growth of 8% in 2008 and 6% in 2009, with emerging markets, including Brazil, Russia, China and India, being the driver.

Some confidence is down. For example, while downbeat, Bain and Company argues that the luxury goods market will head into a recession in 2009. Noting that "the first recession in luxury-goods sales in nearly 20 years has forced on companies modification of their traditional focus on glamour and glitter" and "there are growing signs that the dip in luxury spending is a global phenomenon" with demand for luxury goods expected to drop by 3-15% next year. Confidence in others is up - particularly with "new luxury markets". The most 'accessible' brands (examples include Ralph Lauren and Coach) are down, 'absolute' luxury brands (like Hermes), resilient, even growing. They are likely to remain truly resilient as 'their elitism and brand heritage' appeal to the wealthiest global consumers. In 2008 these 'absolute brands' experienced a +8% growth and are predicted to be immune from the recession (Bain and Company 2008).

Watches and accessories 'seem to be the only categories resilient to economic downturn', driven by growth in emerging economies where watches are usually the first

'luxury' item to be purchased by consumers wanting to get a taste for a luxury image or lifestyle. Consumers are choosing accessories which can be worn with every outfit and that will last for years. Luxist.com reports the handbag is remaining strong in winter/spring collections. Accessories, too, are at the pinnacle of spending in the luxury market, with shoes (+8%) and leather goods (+4%) demonstrating strong growth in 2008 and that growth is not predicted to wane. Research suggest that the billion dollar accessories market is, in fact, benefiting from the economic downturn, as consumers satisfy their shopping and 'luxury fashion' (Boston.com 2009; CTV 2008).

Fashion products using crocodilian skin are regarded as classic, timeless products and they pervade the handbag trends of fall and winter 2009 - designers such as Yves Saint Laurent, Balenciaga, Chloe, Rebecca Minkoff and Versace have crocodile bags in their fall/winter 2009 collections. Dolce and Gabbana fashion house used custom-made crocodile bags for men to epitomize luxury as part of their Spring/Summer 2009 campaign. The collection is limited to 20 unique pieces worldwide, at the cost of about \$55,000 each (Luxist.com 2008).

b. Mainstream luxury sector

In the nearly-luxury segments, sometimes called ready-to-wear, discounting is happening in the face of weak sales - so-called "whisper sales". So-called 'whisper' sales are occurring which very discreetly cut prices. EB (2008) reports in such a tough environment, it'll be a real "Miracle on 34th Street" if high-end Gotham retailers like Neiman-Marcus, Barneys, Macy's or Saks make their numbers this season". Recently Burberry warned that it is now facing tougher markets, especially in the USA, and has lots of additional inventory. Sales at Saks stores (those that have been open for at least a year), fell 23.7% in January 2009. Even the more luxurious stops, among them Bloomingdale's, Bergdorf Goodman and Salvatore Ferragamo, are discreetly cutting prices (EB 2008; NYT 2008a; FREEP 2008).

It is clear that overall the mainstream luxury sector is being hit hard and this will impact on crocodilian products sales.

c. The rest of the market

The majority of crocodilian leather products are not sold at luxury stores. And yet, for these markets, intelligence is not forthcoming. Is the luxury market a sufficient barometer for the health of the entire industry? Or is the real heartbeat of the market and its conservation impact in this larger cheaper sector?

4. Chewing over the supply chain gossip

The retail slump is only one element of concern for the whole supply chain, although this is not a well-reported

industry segment. Here there may be worries over the availability of credit and fears that the terms of this credit will be high. In other "ethical" supply chains, there are already seismic shifts as some NGO-led activities have found their risks perceived as too high during uncertain times and credit has been withdrawn. Is this happening to sustainable use projects? How might this be impacting conservation more broadly?

For the tanneries, according to Heng Long executive Koh Choon Heong: "The rich always spend money", and the company isn't fretting about today's global economic turmoil with its company profits jumping 19% so far this year (MNM 2008). Furthermore, Heng Long sees a sustainable future and plans to double production capacity over the next 5 years (Reuters 2008c). Meanwhile top-end fashion houses like Hermes are claiming they are facing "massive over-demand. We cannot meet demand we are limited by our ability to train new craftsmen" (Couriermail. au 2009), with crocodile leather products being one of their fastest growing lines. Hermes now has vertically integrated supply chains - with their own crocodile farms in Australia to guarantee supply (Reuters 2009b).

In some developing countries, there are reports that exports of crocodilian leather have started to fall since September. David Chiu, President of the Thai Leathergoods Association, expressed concern that next years' orders could fall by 20%. Upstream producers are feeling this with reported falls over the past 3-4 months of 30% in orders. An increasingly important complement to leather is the meat industry. In Thailand, there are reports that meat is feeling the bite - although now Brad Pitt eats it, this might all change (MDT 2008)

Some crocodile experts have argued that Q1 has seen a significant fall in demand from luxury fashion houses for crocodile leather, with some tanneries holding back supplies to see if the situation begins to thaw. Prices have also fallen dramatically, whilst anything but grade one skins are being rejected outright as well as wild skins below 6.5 foot. This increasingly stringent quality standard is thought to be driven by an unwillingness of craftsmen to work with anything but the best quality and arguably the recession provides more opportunity for price and quality negotiation.

5. Wild production and conservation

Reported wild volumes in trade are increasing, with US and Venezuelan exports at the vanguard (IACTS 2007). Yet, there is worry that loss of credit lines for many industry participants will result in amplified financial stress for producers. Depending on how we believe the industry "operates", the changing nature of inter-firm relationships owing to credit availability in the supply chain might prove the most important for the industry and for conservation.

For conservation, there is a need for industry participants to be aware of the potential fallout for those sustainable use

practitioners in the supply chain, and we can hope, value their input accordingly with extension of good credit and payment conditions where appropriate. And where credit is crucial but is withdrawn owing to the nature of trading relationships, there is a good argument for donor agencies to step in.

I argue that now is the time to be bending the ears of your stakeholders - customers, industry participants, policy-makers. Sure, conservation is not foremost in people's minds but ...

6. Illegal trade

Vulnerable crocodilian populations in rural and remote areas of developing countries are impacted by incentives from the illegal trade as well as by the legal. Its size, prices, stability and impacts on conservation remain unclear, and the impact of the crisis on these factors uncertain. However, illegal trade will slowdown if there is slowdown in lower-end markets (where most is sold - ie not in luxury stores). While at face-value this seems like a win for conservation, it remains unclear. Since there is a glut of products in the supply chain, this merely transmits a price signal to the illegal trade - that crocodilian leather is worth less than before. It is unclear if the illegal trade has emulated the legal trade recognizing that stockpiling is key to brand protection and stability. Heng Long's inventory of \$78 million worth of leather might allow the trade to continue harvesting at a constant level throughout boom and bust times. Does this mean effort is transferred to another wild product or illegal activity such as robbery or arms or drug trade, or does it mean increased effort to kill crocodiles so they can make enough money to survive on? (Next Insight 2008; see PFMO 2008).

7. Sheltered, sustainable and secure?

This article is a mere toe-dip into the complexities of the market, ignoring competitor markets such as ostrich, oil price fluctuations and other trends which are of importance. However, there are signs that:

- In total, crocodilian leather products are sheltered from this financial crisis (as it exists today) owing to a diverse and growing portfolio of markets and market segments and a continuing allure among customers;
- Crocodilian leather products that are sold to the wealthiest have little to fear from this financial crisis (as it exists today) owing to liquidity and the relative small cost, but this accounts for a small portion of the market. Regardless these products are the first to spring back into spending mode when times get rosier;
- Currently opportunities exist in niche segments – such as bespoke tailoring;
- Quality is going to drive current and future growth, hinting at the need for supply-chain wide efforts to enhance quality of product - in regards to skin, tan and tailoring and for training of craftsmen to improve;
- Accessories and staples are being increasingly favoured,

including exotic skin goods. Transfer of budget from other products to these could favour sales of crocodilian products; and,

- The loss of credit will impact immediately on all industry participants who rely on a mixture of trade credit, soft loans, and easy payment terms.

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How the Hermes Birkin Bag and *Crocodylus porosus* are Beating the Recession

Whilst researching the impacts of the recession on the demand for crocodile leather and stumbling over some tales of recession-induced woes, it seems Hermes is the shining star - bucking all trends, and potentially single-handedly fuelling demand for exotic skins, like crocodile leather.

Hermes sales rose by 3.2% at current exchange rates to €428.4 million over the first 3 months of 2009, despite the wider market context of a floundering global economy. Much of that growth is attributed to sales of leather goods, which rose 21.7% to €206 million and has been driven by 'robust' expansion in China and Korea (Hermes 2009).

Hermes' Birkin bags fanatics, including celebrities like Victoria Beckham, are paying up to \$US50,000 (with bags made from exotic skins hitting the 6-digit mark) for a single bag with a waiting list of 2-3 years. Beckham reportedly owns \$US2 million worth of Hermes Birkin bags (Murray and Williams 2009).

Three thousand coveted Saltwater crocodile skin bags will be made this year, and limiting them in number maintains the exclusivity, luxury image and mystique surrounding them. No doubt it helps that Hermes' key clientele are unlikely to be affected by the recession and are seemingly "recession proof", but Hermes ability to conjure such furore over a handbag can only be admired. The exclusivity of its brand is partly reflected in its differing sales results for own stores versus distribution networks, with a 16% growth in sales (at current exchange rates) in the former and a decline in the latter. Clearly stepping into Hermes' own stores is a far more compelling shopping experience than that found in its distribution stores.

Experts argue that "the people who can afford these goods are not affected by the recession. Even if they lost millions of dollars in the market, they are still worth hundreds of millions of dollars. If you want something super special, if you want a handmade crocodile bag and you can afford it, Hermes is the only place you'll go".

Hermes, usually very closed-book about its activities, has claimed that "we cannot meet demand. We are facing massive over-demand. We are limited by our ability to train new craftsmen" [Patrick Thomas, CEO, cited in Goldman (2009)]. Craftsmen in a small French town of Pantin, spend up to 2 weeks preparing each bag. In order to guarantee supply Hermes is vertically integrating its supply chain, establishing new farms in Australia: "It can take three to four crocodiles to make one of our bags so we are now breeding our own crocodiles on our own farms, mainly in Australia," and it is looking to add to its existing number of 1400 craftsmen to alleviate the bottleneck it currently faces in turning the leather into the exclusive Hermes handbag.

Whilst Hermes success might not be replicable in any market other than the 'luxury' fashion market, its role in fuelling demand for crocodile skin, and in driving the demand for

high quality skin and skilled, highly trained craftsmen can not be ignored.

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Student Research Assistance Scheme Update

In the second quarter of 2009, 6 projects [Argentina (1), Brazil (2), Philippines (1), South Africa (1), USA (1)] were awarded Student Research Assistance Scheme (SRAS) funding of \$US1000 each.

- Gisela Poletta (Universidad Nacional del Litoral and Proyecto Yacaré, Argentina): Evaluation of pesticide effects on environmentally-exposed wild *Caiman latirostris* populations: genetic, physiological and developmental alterations.
- Rheyda Hinlo (Massey University, New Zealand): Population structure and genetic variation in the Philippine crocodile (*Crocodylus mindorensis*).
- Lizette Bekker (University of Pretoria, South Africa): Steroid profiling in crocodylian urine by gas chromatography/mass spectrometry.
- Mike Vandewedge (Texas Tech. University, USA): Population genetics of the Brown caiman (*Caiman crocodilus fuscus*) on Coiba Island.
- Roberta Rocha da Silva Leite (Universidade do Federal do Piauí, Brazil): Ethnoecology and conservation of Spectacled caiman (*Caiman crocodilus*) in the Ilha Grande Municipality, northeast Brazil.
- Ricardo Freitas Filho (Universidade do Estado do Rio de Janeiro, Brazil): Adaptation of *Caiman latirostris* to urban, rural and coastal habitats - population dynamics, reproduction and diet.

T-shirts for Philippine Crocodile Conservation

The Philippine Crocodile (*Crocodylus mindorensis*) is one of the most threatened species of crocodylian in the world. It is

a medium-sized species, only found in the Philippines, with only two breeding populations remaining - one in northeast Luzon Island and one in central Mindanao Island in the south. Civil strife in Mindanao over the last 30 years has significantly hindered research on that population until recently.

Hence, the Philippine Crocodiles in the remote foothills of the Northern Sierra Madre Mountains in Luzon comprise a critically important population for the conservation of this species in the wild. In this area, the species is known as “bukarot”. The *in situ* conservation program started in 1999 when a young Philippine crocodile was rescued by a farmer, confirming the presence of the species in north Luzon. The subsequent conservation program is now managed by the Mabuwaya Foundation, a registered Philippine non-Government organization. The program has very strong local community and government support and has seen wild crocodile numbers in the area more than double since the program commenced in 2005.

In order to generate additional funds to support the *in situ* activities, and raise awareness of the program, the Foundation has partnered with students from Isabela State University to produce a series of t-shirts. Sale of the t-shirts will help fund:

- Regular surveys of wild crocodiles.
- Management and protection of two Crocodile Sanctuaries.
- Training of local community representatives in monitoring wild crocodiles and the Sanctuaries, and protecting crocodile nests.
- Village sustainability plans that protect crocodile habitat.
- School and community projects that increase awareness of crocodiles and their conservation.
- A head-start program to increase numbers of wild crocodiles.



The t-shirts are available in 3 designs:

1. Bukarot (in white and green, and sizes M, L and XL) (above);
2. Body & Tail (only in black and sizes XL and XXL) (top right); and,
3. Island (in grey and black, and sizes M, L and XL) (bottom right).

Regional Reports



Europe

ESTABLISHING A EUROPEAN SUPPORT PROGRAM FOR PHILIPPINE CROCODILE RECOVERY. We are very pleased and proud to announce that 15 Philippine crocodiles (*Crocodylus mindorensis*) have been imported into Europe. This is the first legal importation of this species into Europe since CITES was enacted, and is the result of many years' work by Rene Hedegaard of the Danish Crocodile Zoo. These crocodiles will form the basis of a conservation program for the species in Europe, based on captive breeding and visitor education.

The Philippine crocodile now only occurs with certainty in the Liguasan Marsh and its headwaters on Mindanao, in Isabela and Abra Provinces in northern Luzon, and on Dalupiri Island north of Luzon. Although the size of wild population is unknown it is believed to be very low, and the Philippine crocodile remains one of the most severely threatened crocodylians in the world. In 2000, a National Recovery Plan was developed by Chris Banks of Melbourne Zoo, Australia. The plan was revised in 2005, and one of the objectives is to coordinate a captive management program for the species. Chris is the International Co-ordinator of the Philippine Crocodile National Recovery Team, and was instrumental in assisting Rene to complete the importation process.

The process began on 14 November 2001, and 4 years later on 15 March 2006 the Memorandum of Agreement (MOA) was finally signed. Rene travelled to the Philippines, and selected microchipped crocodiles at the Palawan Wildlife Rescue and Conservation Centre (PWRCC). Eight males and 7 females, with total lengths ranging from 60 cm to 11cm were selected. The crocodiles arrived in Denmark on 21 December 2006. As with all crocodiles imported under official MOA from the Philippines, the animals remain the property of the Government of the Philippines.

In order to establish a broader program for European zoos, one pair of crocodiles is being transferred to each of five zoos: London Zoo (UK), Chester Zoos (UK), Bergen Aquarium (Norway), Zurich Zoo (Switzerland) and Cologne Zoo (Germany). These transfers are taking place under Wildlife Transfer Certificates approved by the Philippine Department of Environment and Natural Resources (DENR), through its Protected Areas and Wildlife Bureau (PAWB). These Certificates are tied to the MOA. The intention of the transfers is also to increase support for priority *in situ* actions in the Philippines as identified in the National Recovery Plan.



It is suggested to err on the large size when ordering. The t-shirts are available from either Chris Banks (\$AUD30 including postage, but contact for more detailed advice) or Tess Balbas. The Mabuwaya Foundation is changing its bank account, so please e-mail Tess directly for costs and postage advice if wishing to order from the Philippines.

Chris Banks (*Zoos Victoria, Australia; cbanks@zoo.org.au*) and Tess Balbas (*Mabuwaya Foundation, Philippines; mikaela_tess@yahoo.com*).



Figure 1. Careful selection of crocodiles at Palawan by René Hedegaard. Photograph: Remi Andersen.

The five partner zoos have each donated funds for the conservation work of the Mabuwaya Foundation in Isabela Province. These funds have been used to set up and maintain a Philippine crocodile nest protection and head start program. In 2008, 6 nests were identified and protected in the wild, yielding 41 hatchlings of which 29 were collected for the head start program. Twenty-four juvenile crocodiles from 2006 were released back into the wild. The five Zoos have pledged to provide structural funding for *in situ* Philippine crocodile conservation, thereby directly contributing to a recovery of the wild *C. mindorensis* population in the Philippines.

The remaining 5 crocodiles (3 males, 2 females) remain at the Danish Crocodile Zoo. Under the MOA, Rene is responsible for all the crocodiles and their offspring, which includes managing the European Studbook held by the Danish Crocodile Zoo. It is hoped that these 15 crocodiles will not only constitute the first captive breeding population in Europe, but will also raise awareness for the species with the visiting public. Given that these are the first to have been imported legally into Europe, and the amount of time and effort it has taken to obtain the crocodiles, we are proud to now be in a position to offer European support for the Philippine crocodile.

We wish to thank Bergen Aquarium for their assistance and support during the final stages of the project, the PWRCC for providing the crocodiles, the DENR and Protected Areas & Wildlife Bureau in Manila, all five European zoos for their committed support, and of course Chris Banks for his invaluable help, support and time.

Chris Banks (*International Co-ordinator, Philippine Crocodile National Recovery Team*), Merlijn van Weerd (*Program Coordinator CVPED, Director Mabuwaya Foundation*) and René Hedegaard (*Director, Krokodille Zoo*).

South Asia and Iran

Maldives

CROCODILE(?) TRACKS INVESTIGATED. On 28 April 2009, the Maldives National Defence Force sent a team to

Gaafu Alifu atoll, Kondey, to investigate reports of a crocodile on the island. A Kondey Island official said that tracks suspected to belong to a crocodile had been sighted on the southern side of the island. The reptile has not been sighted nor located as yet. [Note: In May 2007 a small crocodile was captured in the Maldives.]

Source: *Minivan News*, 30 April 2009.

Latin America & the Caribbean

Colombia

CROCODYLUS ACUTUS CONSERVATION PROGRAM IN BAHIA PORTETE, COLOMBIA. In a recent act of philanthropy and social responsibility, the private corporation of Carbones del Cerrejon Ltd. (CCL) exhibited leadership in the American crocodile (*Crocodylus acutus*) restoration program in areas within the jurisdiction of the Department of Guajira. Native to the Bahia Portete, located in the northern outskirts of the Colombian coast and various other parts of Colombia, *C. acutus* was in no way thriving prior to the intervention of CCL. In addition to the ecological protection of *C. acutus*, the program has generated positive effects for the local Wayuu community inhabiting the surrounding areas of the research project.

The endeavor was designed to embrace the local guidelines for conservation and management of the species while engaging community participation in an effort to boost local acceptance of the project (Beltran 2000; Thorbjarnarson 2001). One of the primary economic and social benefits of the project is the increase in local ecotourism. As a direct result of the project, the Wayuu community has enjoyed increased revenues from local lodging and sales of community-specific arts and crafts. In the years to come, the local community is expected to continue to reap the benefits of the restoration of *C. acutus*. In order to restore the population, the program attempts to create an environment conducive for *C. acutus* reproduction. Hatchlings are handled with great care and strategically released into native surroundings.

The Bahia Portete is one of only five population areas for *C. acutus* in the country. From 1994 to 1997 a national census of crocodiles recorded only 10 individuals of different reproductive stages (Rodríguez-Melo 2000).

The initial phases of the project involved extensive research to quantify population status and extent of the reproductive season and habits. Prior to the involvement of the participants, little empirical information was available on reproduction. Clearly, an exhaustive research program was necessary in order to develop definitive management plans. In order to gather information, the researchers carried out spotlight surveys (Martínez 1994) and implemented a reproductive classification system developed by Platt and Thorbjarnarson (2000).

Throughout the intensive search for nests and eggs, data were

accumulated to develop a benchmark for future population growth. Eggs and nests were protected and maintained to alleviate any detriment associated with excessive intrusive human interaction (Gutiérrez and Rodríguez 1991; Hutton and Webb 1992). The local Wayuu community was intimately involved with the project and regularly attended community-wide lectures and workshops dealing with topics such as ecological conservation.

A survey during 2007 produced 54 sightings and 24 successful captures (Carbones del Cerrejón Limited 2007). In terms of size structure, the 54 crocodiles sighted were categorised as Class II (28; 51.9%), Class III (30; 55.6%) and Class IV (6; 11.1%).

Ten nests containing a total of 267 eggs were located, of which 244 eggs were measured. Mean clutch size was 26.7 eggs (range 6 to 42), mean egg length was 71.7 mm (range 67.2 to 76.9 mm) and mean egg width was 43.6 mm (range 41.6 to 47.8 mm). Embryonic development suggested that the nests had been laid about two weeks earlier.

During the same first year, every effort was made to immerse the local community in the project (Fig. 1). Research leaders delivered presentations on the benefits of *C. acutus* conservation, and community members were encouraged to work on the project in conjunction with the research teams. In fact, among the Wayuu, *C. acutus* is a vital food resource and local hunting practice involves use of fishing nets as a means of capture.



Figure 1. Meeting with the elders of clans that dominate Bahia Portete.

The second year of the project (2008) focused on monitoring egg incubation period, while furthering management objectives and culminating in another census of the local crocodile population (Carbones del Cerrejón Limited 2008). The second survey recorded 103 individuals, of which 63 were captured (5 were recaptures). The 103 sightings were categorised as Class II (32; 31.1%), Class III (52; 50.5%) and Class IV (19; 18.5%).

Differences in population size and size structure between 2007 and 2008 were attributed to differences in environmental conditions between years. Rain periods cause animals to

move to mouths of creeks in search of freshwater areas, as at those times there is a greater wedge between the mixing of freshwater and brackish waters.

Ten nests containing a total of 248 eggs were located in 2008, of which 244 eggs were measured. Mean clutch size was 24.8 eggs (range 6 to 41), mean egg length was 71.7 mm (range 66.0 to 76.3 mm) and mean egg width was 43.7 mm (range 42.2 to 44.9 mm). Nests were covered *in situ* and periodically checked to estimate time of hatching. Once hatched, hatchlings were transported to the Wildlife Rehabilitation Center of Cerrejón where they were studied further prior to their release into the wild in 2009. Artificial incubation will be established this year.

In spite of the undeniable ecological and socio-economic benefits of the project, the Wayuu community is just now beginning to recognize the value of collaborative teamwork. CCL will continue to embrace the local community throughout its restorative efforts and every effort will be made to involve the Wayuu natives. In addition, local children are involved in the project, and the itinerary is modified in order to suit various age groups (Fig. 2).

This year, researchers will begin enhancing nesting conditions in order to further population growth of *C. acutus*. Activities include population monitoring, analysis of reproductive behavior, and comparing the results of artificial versus natural incubation. The researchers will continue to involve the Wayuu community throughout the various stages of the project. As a result of these initiatives, the Wayuu community along with its native *C. acutus* will continue to reap valuable benefits throughout and beyond the course of the research project.



Figure 2. Wayuu children interact with *C. acutus* hatchlings.

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JUAN AND LORENZO NOW RESCUE THE BABILLA. In Momposina Depresión, the most important marshland complex in Colombia, the babilla (*Caiman c. fuscus*) represents an important source of income for the local community, through trade in meat and skins.

In accordance with national policies and goals, an action plan was developed to conserve *C. c. fuscus* (Palacios *et al.*

2008), with implementation over a 10-year period, beginning at the end of 2007. The first year of the plan was financed by the Environment Ministry, the Regional Autonomous Corporation of the South of Bolívar and a privately-owned caiman farm (Colombian Croco Ltda.).

The objective was to quantify the status of natural wild populations through monitoring (census). In the first year we surveyed babillas in 993 km (19 marshlands), counting animals and nests (eggs). All the activities involved the participation of the community, with hunters employed as guides and being financially compensated with what they would have gained if they were hunting. At the same time they acquired training in aspects of biology, monitoring methodology, nest location, data collection, egg handling, etc.

Leaders were identified, enabling around 300 men and women to work a cooperative manner. The second phase of the program will be oriented towards the sustainable management of *C. c. fuscus*. Hunters will continue to be used to locate and transport nests, as well as locate, capture and collect biological data on caimans.

In this first stage, 400 wages were generated through guides, drivers, professional support personnel, etc. According to the ecological valuation of the marshlands, it was recommended to repopulate the marshland complex of Chimí with 800 adult individuals (400 males, 400 females) - this will occur in the second year.

Perhaps one of the most significant achievements was the development of a "picture story" entitled "Juan and Lorenzo now rescue the babilla", that summarises in a simple manner the experiences obtained during this first stage. The document is available on the CSG website (<http://iucncsg.org/ph1/modules/Publications/reports.html>). The picture book style is an important means of public education, and has been used elsewhere around the world with other species (eg marine turtles) to spread the "conservation" message to local people.

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Mexico

ANOMALIES AND GROWTH OF A *CROCODYLUS ACUTUS* IN PUERTO ESCONDIDO, OAXACA, MEXICO. On 18 May 2008 the Procuraduría Federal de Protección al Ambiente (PROFEPA) confiscated an American crocodile

(*Crocodylus acutus*) at Marinero Beach, Puerto Escondido Oaxaca, that had been captured by a local beach rescuer.

The rescuer declared that he found the crocodile and brought it to his home because some people had indicated they would kill it out of fear. He also declared that the crocodile was living in a lagoon called Lagunita, which covers an area of almost 5000 m² (15° 51'37.69" N, 97° 03'39.89" W). Lagunita is located in the southeast of Oaxaca along the tropical Pacific coast in the Municipality of Santa Maria Colotepec.

The crocodile was a female, with a total length of 109 cm. Although the animal had the typical skin colouration of *C. acutus*, the pattern of dorsal scales was quite atypical, with a complete absence of nuchal scales (usually 4), absence of 4 nuchal scales (usually 6), and the absence of many dorsal scales (Fig. 1).



Figure 1. Atypical *C. acutus* showing anomalies in dorsal scalation and malformed jaws.

In "normal" *C. acutus* the ossified dorsal scales are organized in 16-17 transverse rows and 4-5 longitudinal rows (Álvarez del Toro and Sigler 2001). With this crocodile, most ossified dorsal scales were absent, and only 8 single scales were present - these were large and not organized in definite rows. Where dorsal scales were present and arranged in regular rows, these appeared typical of *C. acutus*. There were 19 double vertical scales and 14 single vertical scales, which is also typical of the species. The crocodile had a malformed upper jaw.

The crocodile was consigned to the Unidad de Manejo de Vida Silvestre (UMA) of Crocodiles in La Ventanilla, in the Municipality of Santa Maria Tonameca, where it could receive the necessary care. On 1 February 2009 we again visited the UMA to verify the crocodile's health status. We measured the crocodile again (114 cm TL), and also recorded unilateral hypotrophy of the left eye, with a formation of a gray circle around the iris, and strabismus (crossed eyes), all of which had appeared over the last 12 months.

Growth rate was calculated as 5.9 mm TL/mth. The animal had been maintained in a 2 m diameter circular enclosure, (60% water, 40% land). During the last 8 months, and at the time of examination, it was housed with an undernourished *C. acutus*, and thus at a density of 1.6 m⁻². Diet was based on chicken every 3 days.

Hernandez (2002) reported mean growth rates of 30 mm/mth for captive 70-160 cm long *C. acutus*. Many factors influence growth rates, including temperature (Aldeira *et al.* 2005), density, food consumed, sex, and genetic influences. The density at which this particular crocodile was kept is considered optimal for this species (Sanchez and Domínguez-Laso 2006). Cupul *et al.* (2002) confirmed that wild *C. acutus* exhibited higher growth rates relative to captive animals, and that in the first years of life females grow to reach reproductive size in a shorter time (Perez and Escobedo 2007).

At the moment, this specimen is the only one that has been reported with these characteristics in the coast of Oaxaca and in the Republic of Mexico. Hernandez Hurtado (pers. comm. 2009) reported that several years ago 60 crocodiles were extracted from the Parque Nacional Lagunas de Chacahua (PNLC) with the permission of SEMARNAT, and transported to a crocodile farm in Culiacan, which was abandoned a little time later. All of the animals were donated to other institutions, and 6 crocodiles that were donated to Tortugario de Culiacan had no dorsal scales.

These malformations may be the result of hybridization with *C. moreletii*, as the latter was introduced to the PNLC. Weaver *et al.* (2008) reported on crocodiles with atypical phenotypic characters in the in Cuba, where *C. acutus* and *C. rhombifer* are sympatric. Hybrids are called "crossed" or "mixtures", and present variation in the numbers of osteoderms and other features. More detailed analysis of this specimen and its habitats is required before reasons for its atypical appearance can be confirmed.

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FIRST RECORD OF A MORELET'S CROCODILE IN THE GRIJALVA RIVER, CHIAPAS, MÉXICO. During a daytime survey (10 January 2009) for monitoring of *Crocodylus acutus* in the Grijalva River, within the "Cañón del Sumidero" National Park, at about 1500 h we noticed a large specimen swimming in a disoriented fashion at the surface of the water. The specific location was close to Bird Island, near the Manuel Moreno Torres Dam (better known as "Chicoasén"). On this occasion the team was accompanied by an Italian television production crew and staff of the Commission of Natural Protected Areas (CONANP).

Approaching the crocodile, we made "guttural" calls, to which it responded. Close to the animal, we noticed that it appeared to have problem with its eyes, which were inflamed and pink in colour. The animal captured by noosing it. Despite some struggling, including repeated biting of the boat, its jaws were quickly secured and it towed to the riverbank.

Here, it was examined, confirming that it was blind, in a generally weak condition, and that it was a male *C. moreletii*. The decision was made to transfer the crocodile to the Regional Zoo "Miguel Álvarez del Toro" (ZooMAT) for more detailed examination and possible treatment, and notifying the Federal Office of the Environment Protection (PROFEPA) of the action.

The specimen was 3.3 m long and weighed 180 kg. Morelet's crocodiles are not distributed in this area, in which only *C. acutus* had previously been identified. We believe that the animal may have been introduced by someone from the Municipality of Chiapa de Corzo about 30 km away, or that it moved from "La Esperanza" Ranch in the Municipality of Villa Flores, more than 120 km away. (This is a site of irregular introductions for over 35 years).

This finding only represents a record size for wild *C. moreletii* - the species rarely exceeds 3.0 m TL - but may also explain the presence of atypical specimens in the river.

Following treatment with antibiotics, vitamins and other drugs to reduce inflammation, the animal become more active. For the first 15 days it was maintained in its pool of water to which tea, made with medicinal grass (arnica, marigold, chamomile, tepezquehuite), was added, to promote rehydration and to reduce inflammation. With physical recovery, the animal has accepted food provided (eg horse meat, chicken and fish), consuming between 6 and 8 kg per week.

It is likely that it will remain in captivity, due to concerns as to its ability to survive with blindness (considered to have been caused through collision with one of the many boats in Cañón del Sumidero). In addition, the area in which it was captured is not considered to be prime *C. moreletii* habitat.

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RECORD SIZE FOR A FEMALE *CROCODYLUS ACUTUS* IN THE GRIJALVA RIVER, CHIAPAS, MEXICO. On 27 November 2008, during a routine night survey of the Grijalva River in the "Cañón del Sumidero" National Park, fishermen informed us of the presence of a large crocodile in the "El Cacao" River, southeast of the "Manuel Moreno Torres" Dam. They also reported that the crocodile appeared to be sick.

We located the crocodile, lying with its eyes closed at the waters' edge. It did not react to our presence, and was easily noosed. It did not struggle after capture, but attempted to swim away briefly, and then all movement stopped soon after. The crocodile was hauled up onto the riverbank, where it showed no sign of life. Attempts to revive it were unsuccessful, and external examination revealed multiple injuries to the tail and body.

The dead crocodile was transported to the Crocodile Museum in the Regional Zoo "Miguel Álvarez del Toro" for necropsy. Deep wounds in the extremities and tail may have resulted in infection, as indicated by chronic hepatic congestion.

The animal was a 4.40 m long female *C. acutus*, weighing 450 kg. There were no marks indicating previous capture, and represented the largest female *C. acutus* reported in the Grijalva River to date (prior to this capture, the largest female recorded was 3.15 m TL). The *C. acutus* population in the Grijalva River has been steadily recovering over the last 16 years, with 13 nests reported during the previous nesting season. The loss of this large female was most unfortunate.

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Science



Recent Publications

Strauss, M., Botha, H. and van Hoven, W. (2008). Nile crocodile (*Crocodylus niloticus*) telemetry: observations on transmitter attachment and longevity. *South African Journal of Wildlife Research* 38(2): 189-192.

Abstract: The aim of this study was to investigate transmitter attachment and longevity on Nile crocodiles (*Crocodylus niloticus*) in the Flag Boshielo Dam, Mpumalanga, South Africa. From August 2002, 15 adult Nile crocodiles were captured over a 19-month period in the Flag Boshielo Dam. Conventional VHF transmitters were fitted to the tails of 8 male and 5 female Nile crocodiles, while a GPS/GSM transmitter was fitted dorsally to the neck of one male and one female Nile crocodile. There was no significant difference in the total lengths of male and female Nile crocodiles captured for transmitter fitment. Overall, 40% of the transmitters failed, while an equal number was broken off. Neither sex, nor total length of the Nile crocodiles predicted longevity of transmitters from time of fitment to time of failure or destruction and loss. In future, the tails of crocodiles should be avoided when attaching transmitters, as conspecifics seem to target this area during agonistic behaviour. Moreover, it is essential that transmitters and their attachment configurations be tested on the target species before a study commences. Lastly, we urge researchers to routinely provide information on the performance of transmitters and their fitment configurations.

Brazaitis, P., Eberdong, J., Brazaitis, P.J. and Watkins-Colwell, G.J. (2009). Notes on the Saltwater Crocodile, *Crocodylus porosus*, in the Republic of Palau. *Bulletin of the Peabody Museum of Natural History* 50(1): 27-48.

Abstract: Surveys of the Palauan saltwater crocodile, *Crocodylus porosus*, were conducted in 2003 to determine population, genetic, morphological and ecological parameters

of this species. A total of 45 crocodiles were observed over 32 survey treks: 42 over 103.06 km of coastline (average of 0.44 crocodiles per kilometre), and 3 in an inland survey of 1.61 ha (0.54 crocodiles per hectare). Age classes from one-year-old to adult crocodiles were observed, and all non-hatchling size classes were represented in the population. No crocodiles over 3.3 m total length and no hatchlings smaller than 35 cm total length were observed. Particularly favored localities were Tayo Bay and coast, Ngkekklau coast, and Airai coast. We estimate 500 to 750 animals are present in all size classes. Genetic analysis confirmed our field observations that only the saltwater crocodile species *C. porosus* inhabits the Republic of Palau and there is no evidence to suggest that the genetic integrity of the wild population has been compromised by the introduction of other crocodylian species. There is, however, evidence suggesting that nonnative *C. porosus* have contributed genetically to the population.

Wamisho, B.L., Bates, J., Tompkins, M., Islam, R., Nyamulani, N., Ngulube, C. and Mkandawire, N. (2009). Ward round - crocodile bites in Malawi: microbiology and surgical management. *Malawi Medical Journal* 21(1): 29-31.

Abstract: We present a case series of 5 patients admitted over 5 months to Queen Elizabeth Central Hospital who had sustained injuries from a crocodile bite. Three patients required amputation of a limb. The severe soft tissue injury associated with a crocodile bite and the unusual normal oral flora of the crocodile create challenges in treatment. Progressive tissue destruction and haemolysis are complications of such infected wounds. An antibiotic regime is recommended that covers gram negative rods, anaerobes and may include doxycycline, as well as the need to have a low threshold for early amputation.

Hussain, S.A. (2009). Basking site and water depth selection by gharial *Gavialis gangeticus* Gmelin 1789 (Crocodylia, Reptilia) in National Chambal Sanctuary, India and its implication for river conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems* 19(2): 127-133.

Abstract: 1. The species diversity of inland waters is among the most threatened of all ecosystems and in many parts of the world it is in continuing and accelerating decline. Such decline could be restrained by acknowledging the scope of target species, so that all relevant stages in their life cycle are considered. 2. The gharial *Gavialis gangeticus* is a prominent riverine species of the Indus, Ganges, Brahmaputra and Mahanadi river systems that is becoming increasingly rare due to reduction in water flow and available nesting beaches, modification of river morphology and increased mortality in fishing nets. Despite these threats, scientific information on habitat selection by gharial is still inadequate, which hinders conservation measures. 3. This paper presents the population status, basking site selection and water depth preferences of different size-classes of gharial based on a study conducted in the National Chambal Sanctuary, India. 4. Between 1992 and 2007 a 40% decline in the gharial population was observed in

the National Chambal Sanctuary. The decline was prominent in the recruitment class (<120 cm), which primarily comes from the nests laid in the wild, and also in sub-adults (>180 to 270 cm) comprising both wild and reintroduced gharial. 5. Along the Chambal River, gharial preferred sandy parts of the river banks and sand bars for basking and showed less preference for rocky river banks and rocky outcrops. Clay river banks were least preferred. 6. Juvenile gharials <120 cm and 120-180 cm preferred water depths 1-3 m and 2-3 m, respectively. Gharial >180 cm (including sub-adults and adults) preferred water depths >4 m. 7. Increasing demands for sand for development activities, and water abstraction for irrigation and energy generation coupled with mortality in fishing nets, are likely to affect gharial and other aquatic species, and steps need to be taken to maintain the minimum river flow necessary to sustain ecosystem processes.

Franklin, C.E., Read, M.A., Kraft, P.G., Liebsch, N., Irwin, S.R. and Campbell, H.A. (2009). Remote monitoring of crocodylians: implantation, attachment and release methods for transmitters and data-loggers. *Marine and Freshwater Research* 60: 284-292.

Abstract: Crocodylians are by their very nature difficult animals to study. However, research on wild animals is essential for the development of reliable long-term management. Here, we describe methods for the acquisition and monitoring of behavioural and physiological variables from free-ranging crocodylians through the use of archival tags (data-loggers) and via satellite, radio and acoustic telemetry. Specifically, the attachment or implantation of electronic tags is described and examples provided of the type of data that can be collected. Our research group has used a combination of approaches to monitor the movements, diving activity, body temperatures and heart rates of crocodylians, including studies on the Australian freshwater crocodile (*Crocodylus johnstoni*), the estuarine crocodile (*Crocodylus porosus*) and the caiman (*Caiman latirostris*). Each approach or method presents unique challenges and problems, chiefly as a consequence of differences in body morphology and size of the crocodylian species, their behaviours and the habitats they occupy.

Bickelmann, C. and Klein, N. (2009). The late Pleistocene horned crocodile *Voay robustus* (Grandidier & Vaillant, 1872) from Madagascar in the Museum für Naturkunde Berlin. *Fossil Record* 12(1): 13-21.

Abstract: Crocodylian material from late Pleistocene localities around Antsirabe, Madagascar, stored in the collection of the Museum für Naturkunde, Berlin, was surveyed. Several skeletal elements, including skull bones, vertebrae, ribs, osteoderms, and limb bones from at least three large individuals could be unambiguously assigned to the genus *Voay* Brochu, 2007. Furthermore, the simultaneous occurrence of *Voay robustus* Grandidier & Vaillant, 1872 and *Crocodylus niloticus* Laurenti, 1768 in Madagascar is discussed. *Voay robustus* and *Crocodylus niloticus* are systematically separate but similar in stature and size, which

would make them direct rivals for ecological resources. Our hypothesis on the extinction of the species *Voay*, which was endemic to Madagascar, suggests that *C. niloticus* invaded Madagascar only after *V. robustus* became extinct.

Lance, V.A., Rostal, D.V., Elsey, R.M. and Trosclair III, P.L. (2009). Ultrasonography of reproductive structures and hormonal correlates of follicular development in female American alligators, *Alligator mississippiensis*, in southwest Louisiana. *General and Comparative Endocrinology* 162(3): 251-256.

Abstract: Ultrasonography has been used effectively to study reproduction in a variety of reptile species, but its application to crocodylians has been relatively limited. We present results from a study testing the efficacy of using ultrasonography to monitor reproduction in the American alligator, *Alligator mississippiensis*. Ultrasound results were then compared with plasma hormone levels. A total of 124 females were examined during March, April, May, and early June (2001-2003). Ultrasound results were validated on a series of reproductive females (n = 14) necropsied for other studies. Previtellogenic follicles, vitellogenic follicles, recently shelled eggs, fully developed well-calcified eggs, and atretic follicles were readily discernible with ultrasound in mature females. Reproductive structures were observed in 57 females of which 43 were actively reproductive, while 14 were non-reproductive, but contained large atretic follicles from prior years. Oviducts were discernible in females with eggs. Ovarian state was also correlated with hormone levels. These results are in agreement with previous studies that showed that 50% or less of the adult female alligator population is reproductively active in a given year. Ultrasonography can be used to make an accurate assessment of reproductive condition in wild alligator populations.

Owerkowicz, T., Elsey, R.M. and James Hicks, W. (2009). Atmospheric oxygen level affects growth trajectory, cardiopulmonary allometry and metabolic rate in the American alligator (*Alligator mississippiensis*). *Journal of Experimental Biology* 212: 1237-1247.

Abstract: Recent palaeoatmospheric models suggest large-scale fluctuations in ambient oxygen level over the past 550 million years. To better understand how global hypoxia and hyperoxia might have affected the growth and physiology of contemporary vertebrates, we incubated eggs and raised hatchlings of the American alligator. Crocodylians are one of few vertebrate taxa that survived these global changes with distinctly conservative morphology. We maintained animals at 30°C under chronic hypoxia (12% O₂), normoxia (21% O₂) or hyperoxia (30% O₂). At hatching, hypoxic animals were significantly smaller than their normoxic and hyperoxic siblings. Over the course of 3 months, post-hatching growth was fastest under hyperoxia and slowest under hypoxia. Hypoxia, but not hyperoxia, caused distinct scaling of major visceral organs-reduction of liver mass, enlargement of the heart and accelerated growth of lungs. When absorptive

and post-absorptive metabolic rates were measured in juvenile alligators, the increase in oxygen consumption rate due to digestion/absorption of food was greatest in hyperoxic alligators and smallest in hypoxic ones. Hyperoxic alligators exhibited the lowest breathing rate and highest oxygen consumption per breath. We suggest that, despite compensatory cardiopulmonary remodelling, growth of hypoxic alligators is constrained by low atmospheric oxygen supply, which may limit their food utilisation capacity. Conversely, the combination of elevated metabolism and low cost of breathing in hyperoxic alligators allows for a greater proportion of metabolised energy to be available for growth. This suggests that growth and metabolic patterns of extinct vertebrates would have been significantly affected by changes in the atmospheric oxygen level.

Silva, J.S.A., Mota, R.A., Pinheiro Júnior, J.W., Almeida, M.C.S., Silva, D.R., Ferreira, D.R.A. and Azevedo, J.C.N. (2009). Aerobic bacterial microflora of Broad-snouted caiman (*Caiman latirostris*) oral cavity and cloaca, originating from Parque Zoológico Arruda Câmara, Paraíba, Brazil. *Brazilian J. Microbiology* 40(1): 194-198.

Abstract: The objective of this study was to isolate and identify the aerobic bacterial microflora from the oral cavity mucosa and cloaca's samples, collected from Broad-snouted caiman (*Caiman latirostris*), born and bred in captivity at Parque Zoológico Arruda Câmara, João Pessoa, Paraíba, Brazil. The most common bacteria were *Staphylococcus* sp. (14.74%), *Corynebacterium* sp. (13.68%), *Escherichia coli* (13.68%) and *Shigella* sp. (11.58%), and the less common were *Citrobacter* sp. (1.05%), *Klebsiella pneumoniae* (1.05%) and *Salmonella* sp. (1.05%). This emphasizes the importance of these microorganisms' participation in infectious processes (sepsis) and injuries caused by crocodilians.

Eme, J., Owerkowitz, T., Gwalthney, J., Blank, J.M., Rourke, B.C. and Hicks, J.W. (2009). Exhaustive exercise training enhances aerobic capacity in American alligator (*Alligator mississippiensis*). *J. Comp. Physiol. B*.

Abstract: The oxygen transport system in mammals is extensively remodelled in response to repeated bouts of activity, but many reptiles appear to be 'metabolically inflexible' in response to exercise training. A recent report showed that estuarine crocodiles (*Crocodylus porosus*) increase their maximum metabolic rate in response to exhaustive treadmill training, and in the present study, we confirm this response in another crocodilian, American alligator (*Alligator mississippiensis*). We further specify the nature of the crocodilian training response by analysing effects of training on aerobic [citrate synthase (CS)] and anaerobic [lactate dehydrogenase (LDH)] enzyme activities in selected skeletal muscles, ventricular and skeletal muscle masses and haematocrit. Compared to sedentary control animals, alligators regularly trained for 15 months on a treadmill (run group) or in a flume (swim group) exhibited peak oxygen consumption rates higher by 27 and 16%, respectively. Run

and swim exercise training significantly increased ventricular mass (~11%) and haematocrit (~11%), but not the mass of skeletal muscles. However, exercise training did not alter CS or LDH activities of skeletal muscles. Similar to mammals, alligators respond to exercise training by increasing convective oxygen transport mechanisms, specifically heart size (potentially greater stroke volume) and haematocrit (increased oxygen carrying-capacity of the blood). Unlike mammals, but similar to squamate reptiles, alligators do not also increase citrate synthase activity of the skeletal muscles in response to exercise.

Benko, T.P. and Perc, M. (2009). Nonlinearities in mating sounds of American crocodiles. *Biosystems*.

Abstract: We use nonlinear time series analysis methods to analyze the dynamics of the sound-producing apparatus of the American crocodile (*Crocodylus acutus*). We capture its dynamics by analyzing a recording of the singing activity during mating time. First, we reconstruct the phase space from the sound recording and thereby reveal that the attractor needs no less than five degrees of freedom to fully evolve in the embedding space, which suggests that a rather complex nonlinear dynamics underlies its existence. Prior to investigating the dynamics more precisely, we test whether the reconstructed attractor satisfies the notions of determinism and stationarity, as a lack of either of these properties would preclude a meaningful further analysis. After positively establishing determinism and stationarity, we proceed by showing that the maximal Lyapunov exponent of the recording is positive, which is a strong indicator for the chaotic behavior of the system, confirming that dynamical nonlinearities are an integral part of the examined sound-producing apparatus. At the end, we discuss that methods of nonlinear time series analysis could yield instructive insights and foster the understanding of vocal communication among certain reptile species.

Gramentz, D. (2009). Zum Schreckruf der Schlitpflinge von *Crocodylus porosus* Schneider, 1801. *Sauria Berlin* 31(2): 13-19.

Abstract: Two different types of the hatchling distress calls of *Crocodylus porosus* were recorded and analysed as to durations, structures, sound pressure levels, and frequency spans. The results are shown in oscillo- and audiospectrograms as well as three-dimensional images. The functionality of these calls is discussed and an overview of field data provided.

Porras Murillo, L.P., Bolaños Montero, J.R. and Barr, B.R. (2009). Genetic variation and gene flow among populations of *Crocodylus acutus* (Crocodylia: Crocodylidae) in three rivers of Central Pacific, Costa Rica. *Rev. Biol. Trop.* 56(3):1471-80.

Abstract: The crocodylid *Crocodylus acutus* is found in the Central Pacific of Costa Rica only in small populations, and

the species is protected by law. RAPD was used to analyze 70 DNA samples of *Crocodylus acutus* from the Jesus Maria, Tarcoles and Tusubres Rivers in the Central Pacific of Costa Rica in order to estimate genetic diversity, differentiation among populations, gene flow and genetic distance between them. Genetic diversity was low in the three rivers, $H = 0.2201$ in the Jesus Maria river, 0.2358 in the Tarcoles river and 0.2589 in the Tusubres river. Among the three populations there is a metapopulation dynamic ($GST = 0.0367$), mainly between the populations of the Jesus Maria and Tarcoles Rivers. The value of gene flow ($Nm = 13.1361$) and the number of individuals reported for each river in 2004 suggests that the population of the Tarcoles River is the source and those from Jesus Maria and Tusubres are the drains. There was a direct relationship between the genetic distance and the geographical distance ($z = 1.1449$, $r = 0.9731$, $p < 0.0010$). A conservation strategy for these crocodiles must consider the existence of the metapopulation between the three rivers and the importance of studying the genetics of the American Crocodile in the rest of the Pacific coast of Costa Rica, as well as over the entire distribution range of this species.

OBITUARIES

Tomas Blohm (1926-2008)

On 11 June 2008, Tomas Blohm, one of Venezuela's most dedicated conservationists and tireless advocate for the Orinoco crocodile (*Crocodylus intermedius*), passed away in Caracas at the age of 81. Born on 30 December 1926, throughout his life Tomas had maintained a vibrant interest in wildlife from which stemmed a stubborn concern for its conservation.

His lifelong dedication to the Orinoco crocodile was the product of a boyhood field expedition in 1946 sponsored by the La Salle school in Caracas. This was Tomas' first experience in the wilds of Venezuela, and while traveling along the middle Orinoco River, the group spent 16 days in the vicinity of Isla Pararuma, renowned for its congregation of nesting giant river turtles (*Podocnemis expansa*). There on Playón del Medio, a sandy midstream island, Tomas found a nest on the collapsing edge of a sandbar being eroded by the Orinoco's rising waters. Checking the half-opened nest, Tomas found one egg that was much larger than the rest, from which emerged twin hatchlings as he was holding it. So began a lifelong fascination for crocodiles that eventually blossomed into a conservation program based on his ranch, Fundo Pecuario Masaguaral, in the Venezuelan Llanos.

Tomas began promoting Masaguaral as a site for wildlife research in the 1970s. Masaguaral's rich variety of habitats and healthy wildlife populations offered splendid research opportunities for scientists from Venezuela and abroad. Some of the early research was published in a book in 1979 [John Eisenberg (1979). Vertebrate Ecology in the Northern Neotropics. Smithsonian Press], and over the years Masaguaral became a major center for research on the Llanos fauna. Studies were carried out on a wide range of species,

in particular primates (howler and Cebus moneys) and other mammals (ocelots, giant anteaters, opossums, capybaras), the avifauna (hoatzins, curassows, parrots, vultures, raptors and wrens), as well as reptiles (caiman and iguanas).

Over the years Tomas hosted an eclectic group of scientists and students in a simple but functional lifestyle and built a ramshackle series of houses that evolved into a biological station perched at the edge of Masaguaral's seasonally flooded marshes. Masaguaral was the training ground for a number of generations of researchers and the scientific production from Masaguaral has been enormous, resulting in over 260 publications in peer-reviewed journals.

Among the members of the CSG, Tomas was best known for his efforts to protect the Orinoco crocodile. In 1975, Tomas and his wife Cecilia became founding members of FUDENA, a Venezuelan NGO dedicated to the conservation of the country's biodiversity. Together, Tomas, Cecilia and FUDENA sponsored the first ever population evaluation of Orinoco crocodiles in Venezuela, which was carried out by Robert Godshalk in 1977-78. Tomas had long been considering the establishment of a captive breeding program for the species, and in 1977, he acquired an adult pair of Orinoco crocodiles that had previously been housed in a private zoo of a cement factory on Venezuela's coast.



Tomas receiving his first adult Orinoco crocodile for the breeding program, in 1978. Photograph: Robert Godshalk.

The crocodiles were placed in a lagoon on Hacienda Refugio de Fauna El Paraiso, a property adjacent to the Camatagua Reservoir in Aragua State, and successfully bred for the first time in 1980. However, the site proved less than ideal and in 1984, in conjunction with FUDENA hosting the 7th CSG Working Meeting in Caracas, Tomas began construction of a new facility on Masaguaral. A series of breeding enclosures and grow-out pens were situated around a small house that soon became known as the "Caimanera". One of us (JT) had the good fortune to be hired by FUDENA in 1984, then led by Cecilia Blohm, to work with Tomas at the breeding center and develop a conservation program for Orinoco crocodiles. The goal of the project, and Tomas' long-standing dream, was to be able to breed crocodiles in captivity and release them back into the wild.

The first successful breeding of crocodiles on Masaguaral was in 1985, when the female crocodile laid her eggs on Valentine's Day and they hatched on Mother's Day, something that Tomas took due note of and told everyone who would listen. Over the following decade the breeding stock of crocodiles on Masaguaral increased, principally through donations of captive animals, as did the number of nests and hatchling crocodiles. In 1990 a milestone was reached with the release of the first captive-reared crocodiles in an area on the Hato El Frio cattle ranch located adjacent to the newly declared Caño Guaritico Wildlife Refuge.

In that first year 31 crocodiles were released, including 16 from Masaguaral. Since 1990 a total of 6355 captive-reared crocodiles have been returned back to the wild in Venezuela, of which 2475 were from Masaguaral. Although follow-up monitoring has been spotty, we know that at least one of the release sites (Caño Guaritico WR) now has a healthy breeding population that originated entirely from released crocodiles. The future for this crocodile now looks much brighter than it did two decades ago when Tomas started his Masaguaral program, and a great deal of the credit must be given to Tomas. To a large extent his dream of returning Orinoco crocodiles to the wild has been fulfilled.

John Thorbjarnarson (*Wildlife Conservation Society, PO Box 357520, Gainesville, FL 32635 USA*) and Gabriela Blohm (*Department of Biology, University of Florida, 223 Bartram Hall, PO Box 118525, Gainesville FL 32611, USA*).

Gregory Colomine

Gregory Colomine, "El Checo", passed away on 1 May 2009. His last years were dedicated to the conservation and sustainable use of crocodilians in Venezuela. From 1994 to 2004 as Scientific Coordinator of the Coordination of Extension of the Faculty of Sciences of the Central University of Venezuela, he led the team that undertook monitoring of wild *Caiman crocodilus* populations subject to annual harvesting. Between 1999 and 2001 he was Director of Environmental Quality of the Ministry of Environment, and in his final years he worked on the design of studies for Environmental Management of the Bolivariana University of Venezuela, as Socio-Academic Director. He was a recognized member of the Crocodile Specialist Group, as much by his contributions to conservation and sustainable use as his capacity to socialize and enjoy the different events that we had the honor to share with him. Gregory is survived by wife Maria and five children.

ROBO CROC DIES. A 3.1 m American crocodile (*Crocodylus acutus*) that underwent extensive surgery after being hit by a car in the Florida Keys in December 2008, died in early April 2009. Named "Robo Croc" because of the 4 steel plates and 41 screws placed into its skull during surgery, the crocodile finally succumbed to the serious injuries that it had received during the collision.

Sources: www.justnews.com/news/19077801/detail.html,
www.justnews.com/news/18951678/detail.html

"Crocodiles"

"Crocodiles", by Luc Fougéirol, reflects his passionate interest in crocodilians. Many CSG members would remember Luc from the 18th CSG working meeting, which he and his family hosted in 2006. Luc's interest in crocodilians began at the early age, and in 1994 he and brother Eric established La Ferme aux Crocodiles at Pierrelatte. Through the farm and "SOS Crocodiles", Luc continues to contribute to the conservation of crocodilians around the world.

In both English and French, "Crocodiles" comprises 192 pages, with some 150 photographs of the world's 23 species of crocodilian. The book is a co-production with La Ferme aux Crocodiles. Purchase of the book represents an investment in conservation of crocodilians.

"Crocodiles" is widely available, and CSG members may purchase it from La Ferme aux Crocodiles and the Montélimar Tourist Office. At a cost of 32€, it can be ordered online (http://www.montelimar-tourisme.com/montelimar-boutique.php?page=boutique_montelimar.php).

Citation: Fougéirol, L. (2009). Crocodiles. Editions de La Martinière: France.



For further information, contact: Emmanuelle Rivas, Director, Montélimar Tourisme, Allées Provençales - Montée St Martin - 26200 Montélimar, France; Tel. 33.475.010020; www.montelimar-tourisme.com; info@montelimar-tourisme.com.

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