CROCODILE SPECIALIST GROUP NEWSLETTER

VOLUME 31 No. 3 • JULY 2012 - SEPTEMBER 2012

IUCN • Species Survival Commission

CROCODILE

SPECIALIST

GROUP

NEWSLETTER

VOLUME 31 Number 3
JULY 2012 - SEPTEMBER 2012

IUCN - Species Survival Commission

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Printed by: Uniprint NT
Charles Darwin University, NT 0909, Australia

COVER PHOTOGRAPH: Saltwater crocodile (*Crocodylus porosus*). Photograph: Grahame Webb.

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The CSG Newsletter provides information on the conservation, status, news and current events concerning crocodilians, and on the activities of the CSG. The Newsletter is distributed to CSG members and to other interested individuals and organizations. All Newsletter recipients are asked to contribute news and other materials.

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George Saputra, IRATA, Jakarta, Java, Indonesia.

Yosapong Temsiripong, "Sriracha Moda" and "Crocodile & Ostrich Cooperative of Thailand", Thailand.
The Marine Products Association, Hong Kong.

Contributors ($250 - $1000)

East Coast Zoological Society (Brevard Zoo), FL, USA.
Carl Camden, Kelly Services Inc., USA.
Simone Comparini, Pantera S.R.L., S. Croce s/Arno, Italy.
Luis Gonzaga, Sitio do Carração Ltda., Brazil.
James Hennessey, Reptile Village Zoo, Ireland.
Indonesian Crocodile Farmers Association, Indonesia.
Rob Gandola, Ireland.
Vic Mercado, Microlab, Philippines.
Ari Palomo Del'Alamo Criatório Caiman Ltda., Brazil.
J. Perran Ross, Gainesville, FL, USA.
The Ebey family, New Mexico, USA.
Nao Thouk, Phnom Penh, Cambodia.
Virginia Aquarium, Virginia Beach, VA, USA.

Editorial

It was extremely sad for the CSG to hear that another long-time CSG member, Saul Elías Gutierrez Eljuri (51 y), passed away in Venezuela on 17 August 2012, following a stroke and a short time in hospital. During his career, Saul was Director of the terrarium in the Parque del Este Zoo in Caracas, and founded the first Biological Station in the Orinoco Basin, dedicated to breeding and raising a variety of species in a safe and sustainable environment. He was involved continually in crocodile conservation in Venezuela, and was active in the establishment of the Venezuelan Crocodile Specialist Group. We extend our condolences to Saul's wife and children.

The CITES Standing Committee held its 62nd working meeting in Geneva (July 2012). The Working Group on Ranching Operations in Madagascar, had recommended: "Based on the written information provided by Madagascar at SC62 that outlined its progress to date in implementing the recommendations made by SC60, the majority of the Working Group members (France, Germany, Japan, the United States, IUCN and the Secretariat) considered that insufficient information had been provided by Madagascar to warrant the withdrawal of the recommended trade suspension". This recommendation was accepted and the matter will now be considered again at SC63. The CSG is of course keen to see Madagascar implement a sustainable harvest program, that is legal, sustainable and verifiable.

Following the 21st CSG meeting (Manila, May 2012), a number of actions have been implemented. Changes to the CSG Steering Committee include the appointment of: Anslem de Silva as Regional Chairman and Ruchira Somaweera and Maheshwar Dhakal as Regional Vice Chairmen for the South Asia & Iran Region; Clara Lucia Sierra Diaz as Vice Chair of the new Community Education Group; Dr. Parntep Ratanakorn as Chairman of the newly-formed Siamese Crocodile Task Force; and, Alan Woodward as Chairman of the Human-Crocodile Conflict Working Group.

With the agreement of the Lao PDR Government, a CSG mission will be undertaken in early December 2012 by Dr. Parntep Ratanakorn, Yosapong Temsiripong and Tom Dacey. The CSG also proposes to send a high level delegation to Indonesia to discuss crocodile management in general, but with a specific focus on populations of *C. siamensis* and *T. schlegelii* in Lake Mesangat, East Kalimantan.

The Northern Territory Government is seeking approval of a modified management program, which would allow trial safari/sport hunting of up to 25 *C. porosus*. Following consultation with CSG members, the Executive Officer provided comments to the Australian Federal Government. The CSG fully supports the proposed amendment to the NT Management Plan and recommends its approval by the Federal Minister under Subsection 303FO(3) of the *Environment Protection and Biodiversity Conservation Act 1999*.

A final report on the 2012 IUCN-SSC Chairs' Meeting (Abu Dhabi, February 2012) was circulated to all members for their information. The overall feeling of the participants was that the meeting was a huge success, and built a new sense of teamwork and vision within the SSC leadership. The meeting also laid the foundation for the upcoming Quadrennium, helping SGs to consider their strategy and devise new ways on engaging their membership and the wider community.

In early July, Chinese police intercepted three trucks loaded with some 3600 Siamese crocodiles being smuggled from Vietnam into China. The incident occurred in Tongmain Town, Guangxi, Zhuang region, close to the border with Vietnam. Three "foreigners" were arrested and charged.

Compilation of the Proceedings of the 21st CSG Working Meeting is almost complete, and will be submitted for printing soon. Advice will be provided to CSG members and participants on the availability of the Proceedings in due course.

In response to growing incidence of Human-Crocodile Conflict in India, Madras Crocodile Bank Trust organised a HCC symposium during the Society for Conservation Biology conference in Bangalore, India, August 2012. The meeting assembled some of the main players to discuss the issue and begin drafting a plan to address HCC within India.

The website for the 22nd CSG Working Meeting (Colombo, Sri Lanka, 20-23 May 2013) is at: www.csgsrilanka.com. It has details on the proposed program, registration, accommodation and submission of abstracts and papers. The success of CSG working meetings relies on attendance to those meetings, and we urge people to try their utmost to attend. As the first meeting in the South Asia & Iran region since 1978, it is important that we throw our support behind it.

Annual letters of request were sent to CSG donors, whose support to the CSG is critical to its ability to operate, particularly in these difficult economic times. Donations have begun to arrive, and I am personally very grateful to all who have made a contribution, past and present.

Professor Grahame Webb, Chairman

Obituary

Saul Elías Gutierrez Eljuri

(17 November 1960 - 17 August 2012)

The biology world has lost a great figure in the passing away of Saul Gutierrez. A lifelong proponent of ecological conservation and education, his reach extended far beyond the expected limits of a man so in love with his native land, Venezuela. Saul graduated from Simón Bolívar University in Caracas, Venezuela, in 1985, specializing in reptiles - his thesis was the first study on the health benefits of the meat of *Caiman crocodilus*. The following year, he began farming fish for human consumption, and establishing a safe and sustainable source of protein. As the wildlife advisor at El Cedral Ranch, he established conservation programs for Capybara (*Hydrochaeris hydrochaerus*) and *Caiman crocodilus*, and developed a breeding program for the Orinoco crocodile (*Crocodylus intermedius*), successfully reintroducing this endangered species into its natural habitat.

In 1997, he was made director of the terrarium in the renowned Parque del Este, in Caracas, where he kept and raised a variety of local reptiles and amphibians and developed education programs for both children and adults, teaching the value of understanding their biology and why their conservation is important to natural ecosystems. In 2005, he founded the first Biological Station in the Orinoco Basin, dedicated to breeding and raising a variety of species in a safe and sustainable environment. These institutions made possible several important studies on biology, conservation and sustainability of freshwater turtles and crocodiles.

He was passionate about balancing the ecosystem, creating opportunities for both humans and fauna to thrive. The Arrau Sideneck Turtle, once abundant in Venezuela, had been seriously reduced, due to cannibalism - adults devouring the offspring - and negligent poaching. Every September, the turtles' traditional spawning month, Saul would go down to their breeding grounds and take the baby turtles to the terrarium, giving them a place to grow and develop safely before being released back into the wild. Thanks to his efforts and those of other Venezuelan biologists, the population of Arrau Sideneck Turtle is now closer to its ideal population. He understood that man had a God-given dominion over nature and its bounty, but that power gave us a responsibility to maintain it for the generations. He also worked in several breeding projects of local fauna, including Venezuelan tortoises. As much as he loved his country, he worked in conjunction with BBC and National Geographic to show the world our natural wonders.

A man of science lives on in the hearts of those he taught, of those who laughed and loved and learned from him. If that is so, may Saul Gutierrez live forever, in the memories of his friends, his family, his students, personal of his park, beneficiaries of his legacy projects, and all those who look out over the Llanos and see rivers teeming with turtles, crocodiles, snakes and fish, frogs and all the elements of nature that depend on them, enduring evidence of a man who loved life, and dedicated his own to protecting it.

Saul was a founding and active member of the Venezuelan Crocodile Specialist Group, and a member of various zoological institutions in North and South America. He developed close ties with the BBC, offering them various insights and assistance on documentary shoots in Venezuela. David Attenborough remembers him as a good man, and a friend.

Saul is survived by his wife Monica, and his children, Irina and Diego.

Monica de Gutierrez, *with information from many people*.

22nd CSG Working Meeting

Colombo, Sri Lanka, 20-23 May 2013

The 22nd CSG Working Meeting will be held in Colombo, Sri Lanka, from 20-23 May 2013. This represents a slight deviation from normal CSG practice, in that this meeting will take place 12 months after the 21st Working Meeting (Manila, May 2012).

With a "Living with Crocodilians" theme, we encourage people to participate in what will be the first CSG Working Meeting in the South Asia and Iran region since 1978.

Details on the meeting are now available at <csgsrilanka.com>.

Addendum

Note: The authorship (Bed Bahadur Khadka, Assistant Conservation Officer, Gharial Conservation Officer, Chitwan National Park, Nepal, <bed_khadka@yahoo.com>) of two articles published in CSG Newsletter 31(2) was accidently omitted from the final versions. Citations are:

Khadka, B. (2012). 100 Gharial released into Chitwan National Park, Nepal, January-April 2012. Crocodile Specialist Group Newsletter 31(2): 15-16.

Khadka, B. (2012). Monitoring of Gharial and Mugger in the Narayani and Rapti Rivers of Chitwan National Park, Nepal, February 2012. Crocodile Specialist Group Newsletter 31(2): 14-15.

New Taxonomic and Nomenclatural Proposals Called into Doubt

Crocodilian researchers reacted with skepticism and concern to material released recently that proposes changes to crocodilian taxonomy and names. Raymond Hoser, an Australian reptile exhibitor and educator, distributes a blog he calls "Australasian Journal of Herpetology". Mr. Hoser appears to be the owner, manager, editor and sole contributor to the site. In his June posting, is a section titled 'A review of the taxonomy of the living Crocodiles including the description of three new tribes, a new genus and two new species', Mr. Hoser has published similar postings reorganizing and renaming snakes and lizards that aroused critical comment and negative review by experts in those fields (eg Wallach *et al*. 2009; pp. 29). Mr. Hoser's crocodilian discussion takes several well-known nomenclatural issues in the crocodilian world and proposes new generic, species, subgeneric, and tribal designations. He proposes these changes somewhat provocatively as a response to the 'laziness' of herpetologists and the stated goal of clarifying the 'true phylogeny of the entire extant Crocodylia'. Unfortunately, his desire to clarify and stabilize crocodilian nomenclature results in the opposite effects of destabilizing a well-accepted taxonomy and confusing discussion of the topic.

Topics such as the separation of the New Guinea crocodile into two species, and the examination of the genetic basis for recognizing cryptic species in both the Nile and African Dwarf crocodiles are under active study. However, it seems a dubious ethical practice to try and pre-empt the many workers actively researching these topics. The division of *Crocodylus* by the resurrection of several old names long discarded or placed into synonymy by modern taxonomists (eg *Motinia* Gray1844, *Oopholis* Gray 1844, *Philas* Gray 1874); grouping some species into groups that are not supported by all available evidence and that remain controversial (eg combining Tomistoma and Gharial); and, creating a new genus named after his dog and two new species named after his daughters all require careful justification and peer review. There is nothing inherently incorrect about proposing scientific names on this basis, but the intention has been perceived as frivolous and disrespectful by taxonomists.

Taxonomic changes should be based on sound science and good scholarship. Although couched in apparently learned terms of diagnosis and reference to type specimens, on close examination, many of these appear to be arbitrary, incorrect or not based on actual examination of the specimens cited. The discussion is also flawed by errors, for example spelling names for the same species in two different ways, imprecise definition of morphological characters, errors of species name priority and failure to recognize variation in scale numbers. The diagnosis of phenotypic characters for the new species are not supported by description of the cited specimens, samples sizes, localities or literature citation of these details and in several cases are incorrect or incomplete. Genetic information that does not support the proposals is distorted, misinterpreted or ignored, as is the extensive literature on fossil forms, despite citing several papers on the topic. There are fewer than 30 living species of crocodilian, but more than 200 known only from fossils - taxonomic revisions that ignore almost 90% of the diversity of a group are incomplete. Some commentators have questioned whether unreviewed vanity publishing of this kind constitutes adequate publication under the rules of nomenclature.

Frivolous taxonomic speculations and distortions will be dismissed and ignored by most practical and conservation interests as being irrelevant, erroneous or both. However, poorly founded taxonomic revisions can have permanent destabilizing effects and require onerous effort and additional publication to refute and discard. Everyone interested in crocodilians supports a valid scientific taxonomy, and zoological nomenclature established under the International Committee of Zoological Nomenclature (ICZN) is relatively stable. However, because international trade in their valuable skins is regulated by CITES, the need for a stable and recognized crocodilian taxonomy is particularly important. CITES requires that all crocodilian skins moving in international commerce must be tagged and identified to species. Traders could use newly published names to avoid trade controls until the CITES Appendices, and numerous national and local laws and regulations implementing CITES, can be amended. Several researchers are preparing papers exposing and refuting what they consider to be evidence-free taxonomic fantasies, and encouraging the ICZN to address the problem of un-reviewed taxonomy. A current proposal, that we support, is that all workers should set aside and ignore Hoser's names until the ICZN has an opportunity to consider and rule on the matter.

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Perran Ross (*CSG Red List Focal Point, pross@ufl.edu)*, Kent Vliet *(Department of Biology, University of Florida)*, Matt Shirley (*Department of Wildlife Ecology and Conservation, University of Florida)*, Chris Brochu *(University of Iowa)* and F. Wayne King *(kaiman@ufl.edu).*

New EU Regulations to Ease Internal Trade and Sale of Certain Crocodilian Products

New EU regulations will significantly ease the commercialisation within the EU of specimens produced in crocodilian captive breeding operations. From 27 September

2012, the marketing of dead specimens or derivatives of CITES Appendix-I crocodilian species originating from CITES-registered captive breeding operations (www.cites.org/common/reg/e_cb.html) with source code 'D' on the CITES Export Permits, can be commercialised within the EU without an EU-specific certificate which would have previously been issued on a case-by-case basis by the respective CITES Management Authority. According to EU law, "commercialisation" includes internal purchase, offer to purchase, acquisition for commercial purposes, display to the public for commercial purposes, use for commercial gain and sale, keeping for sale, offering for sale or transporting for sale of specimens, etc.

CITES is uniformly regulated in the EU through Council Regulation (EC) No 338/97 *on the protection of species of wild fauna and flora by regulating trade therein* and Commission Regulation (EC) No 865/2006 *laying down detailed rules concerning the implementation of Council Regulation (EC) No 338/97* (both are available at http://ec.europa.eu/environment/cites/legislation_en.htm). The new Commission Regulation (EU) No 791/2012 of 23 August 2012 now amends certain provisions relating to Regulation (EC) No 865/2006, and thus the implementation of Council Regulation (EC) No 338/97. Specifically, new provisions (point 4) which refer to Article 62 of Regulation No 865/2006 were inserted in paragraph (18).

In future when specimens derived from CITES-registered captive breeding operations are commercialised, it will be sufficient to prove only that these have been legally imported into the EU in accordance with the respective applicable regulations, for example by means of a copy of the customs endorsed import permit or if these are identifiable via other means in accordance with the provisions of the respective EU regulations.

Currently, commercial captive breeding operations for Appendix-I-crocodilians listed on the CITES Secretariat's register exist in Cambodia, China, Colombia, Cuba, Honduras, Malaysia, Mali, Philippines, Senegal, Singapore, Thailand and Vietnam, involving *Alligator sinensis, Caiman crocodilus, Crocodylus acutus, C. niloticus, C. porosus, C. rhombifer* and *C. siamensis*.

Dietrich Jelden, <*dietrich.jelden@bfn.de*>.

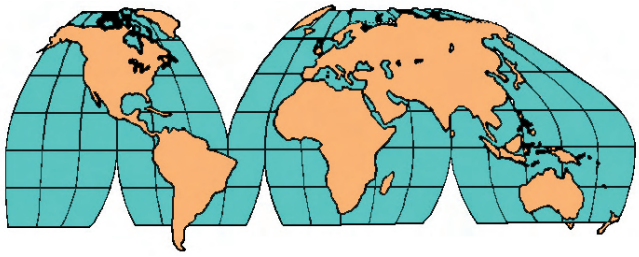
Student Research Assistance Scheme Update

One SRAS proposal was accepted in Jul-Sep 2012 (below), bringing the total to 11 students in 2012 so far:

1. Matthew Brien (Australia): Agonistic behavior in hatchling crocodilians.

Tom Dacey, *CSG Executive Officer, csg@wmi.com.au.*

Regional Reports



Latin America and the Caribbean

Jamaica

JAMAICAN CROCODILE CONSERVATION. American Crocodiles (*Crocodylus acutus*) in Jamaica are subject to increasing levels of persecution, illegal killing for food and habitat loss. Laurence Henriquez, a Jamaica native and crocodile enthusiast (see CSG Newsletter 14(4): 12-14, 1996), returned to Jamaica in 2009 after several years overseas and was deeply alarmed by the situation. Laurence has teamed up with other Jamaican crocodile interests in Jamaica and in CSG, including Byron Wilson (University of the West Indies, Mona), Charles Swaby, Frank Mazzotti and Perran Ross, and has initiated studies and rescue of crocodiles at Holland Bay in eastern Jamaica (see Fig. 1).

Figure 1. Distribution of *Crocodylus acutus* in Jamaica.

A disturbing new picture of crocodile status in Jamaica is emerging. The loss of habitat and regular killing of crocodiles by people has increased, and the impacts are now thought to be severe. The previous limited tolerance of rural people for crocodiles appears to be eroding. The numbers of crocodiles, successful reproduction and occupied sites all seem to be in serious decline. Several factors are supporting this emerging conservation crisis. Jamaica is in severe economic difficulty, with no effective political or public support for crocodile conservation. Authorities have little capacity to enforce wildlife laws and no incentive or enthusiasm to do so given other urgent pressures. A new demand for crocodile meat, both for personal consumption and for local market distribution has emerged, and many crocodiles are reportedly killed for this purpose. The Government's National Environment and Planning Agency (NEPA), has very limited capacity and has taken no discernible action in response to these concerns.

Following consultations among Jamaican interests and CSG, a letter was prepared and sent from CSG Chair Grahame Webb to NEPA in October 2010; Jamaican interests followed up with a meeting with NEPA. While this interaction caused a transient increase in interest, little or no concrete action has followed.

In the meantime, Laurence Enriques has established a sanctuary facility at his property at Springvale, St. Mary Parrish, and collected and housed a number of juvenile and sub-adult specimens rescued from threatening situations Fig. 2). A number of crocodiles were captured, marked and released at Holland Bay where they receive some protection from private landowners and sympathetic local people and 6 crocodiles have been fitted and released with radio-transmitters. Rescuing crocodiles and holding them in captivity is insurance against future loss and the foundation of an educational program to promote crocodile conservation among rural Jamaicans.

Figure 2. Adult *Crocodylus acutus* rescued by Laurence Henriques, St. Marys, and held for conservation insurance. Photograph: Laurence Henriques.

These developments were reported to the CSG Steering Committee in May 2012. The current status appears to be that crocodiles remain, in small numbers, widely distributed among small and isolated habitat patches, primarily in the Black River Morass, central southern coast and far eastern marshes and canals. Numbers continue to decline due to continued habitat loss, persecution and illegal harvest for meat. A small team of interested local activists remains but expanding interest in crocodile conservation to a wider advocacy base has not been successful. The situation appears dire with a real potential for the effective extirpation of crocodiles from Jamaica in the foreseeable future if current trends continue and more effective intervention is not developed.

Laurence Henriques *(lphenriques1@gmail.com)*, Byron Wilson *(byron.wilson@uwimona.edu.jm)* and Perran Ross *(pross@ufl.edu)*.

Colombia

ECOLOGY, POPULATION STATUS AND HUMAN INTERACTIONS OF *CROCODYLUS ACUTUS* AT ZAPATOSA AND COSTILLA SWAMPS, CESAR DEPARTMENT, COLOMBIA. After *Crocodylus rhombifer* and *C. intermedius* (Critically Endangered; IUCN 2012), *C. acutus* (Caimán aguja) is the most threatened member of the Family Crocodylidae in South America (Vulnerable; IUCN 2012). It occurs in 18 countries, and ranges from Florida (USA) to Peru, on both the Atlantic and Pacific coasts (Thorbjarnarson 2010). In Colombia, *C. acutus* was historically distributed on the Caribbean coast (including all islands except the San Andrés Archipelago, Providencia and Santa Catalina) and on the Pacific coast, as well as inter-Andean rivers and tributaries (Medem 1981), at a height not exceeding 500 m asl (Rodriguez 2000). Currently, the species has a fragmented distribution, with isolated populations in areas with low anthropic impact (Rodriguez 2000; Thorbjarnarson *et al*. 2006; Thorbjarnarson 2010; Balaguera-Reina and Gonzalez-Maya 2008, 2009; Balaguera-Reina *et al*. 2012).

In July 2011, a study was carried out to provide information on the ecology, population status (abundance) and human interactions of *C. acutus* at Zapatosa and Costilla Swamps. The study was undertaken within a broader study entitled "the

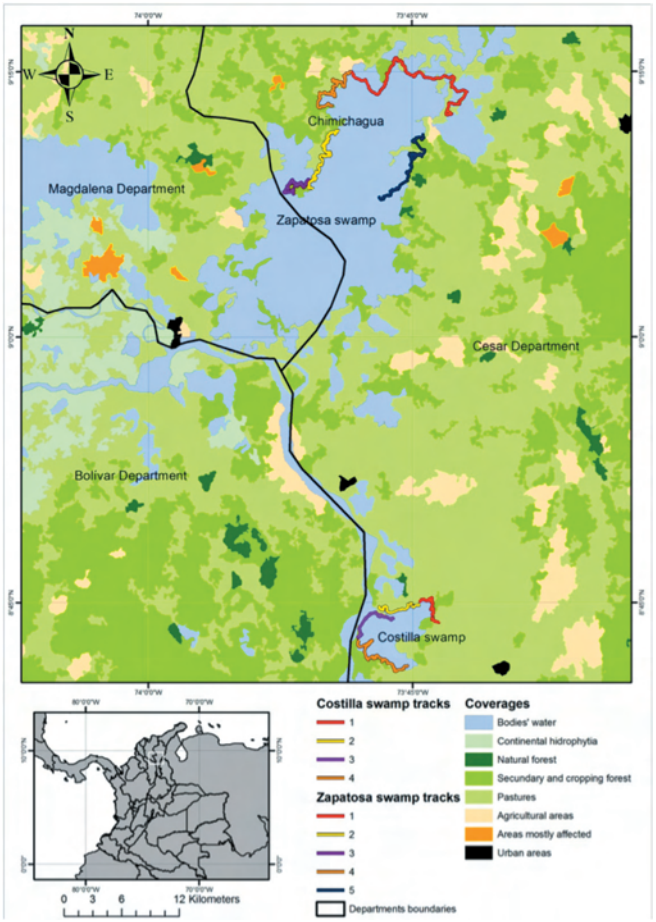


Figure 1. Study area and survey sections in Zapatosa and Costilla Swamps.

environmental, social and economic conditions evaluation for the restocking of *ex-situ Caiman crocodilus fuscus* population by the Environmental Regional Agency (CORPOCESAR) project" (Balaguera-Reina 2011, 2012).

Zapatosa and Costilla Swamps have an area of 401.06 and 33.76 km^2 respectively, and belong to the Chimichagua and Pelaya Municipalities (IDEAM *et al*. 2007). Riverside vegetation comprises mainly pasture and agricultural areas (modified natural habitats), and some secondary and relict natural forest (IDEAM *et al*. 2007; Fig. 1).

Semi-structured interviews were carried out with 59 fishermen inhabiting and/or working in these swamps using the Snowball Sampling (see Goodman 1961; Ortega-Huerta and Medley 1999). Daily random searches were made looking for evidence (eg tracks, nests, hunted animals) of the species in the area. Spotlight surveys were carried out over 9 nights in Zapatosa Swamp [5 sections (Fig. 1); total= 80.34 km, corresponding to 25.8% of the total swamp perimeter] and Costilla Swamps [4 sections (Fig. 1); total= 33.35 km, corresponding to 86.9% of the perimeter], using a 6-m wooden boat and outboard motor (40 HP), carried out between 1900 and 0200 h and up to 7 km/h (Ulloa-Delgado and Sierra-Díaz 2002).

Interviews were undertaken at four townships (Candelaria, Sanpegua, Saloa and Costilla) in Chimichagua and Pelaya Municipalities. The majority (62.7%) of respondents were over 31 years of age (range 31 to 72), and most (74.6%) had seen *C. acutus* in the last 10 years.

Of the 44 interviewees who had sighted the species in the last 10 years:
- 86.4% (38) considered *C. acutus* to be scarce;
- 63.6% (28) considered sightings of *C. acutus* more likely at the end of the year;
- 61.4% (27) considered the *C. acutus* population had decreased;
- 34.1% (15) considered hunting as the main reason for the population decline;
- 72.7% (32) were not familiar with *C. acutus* nests;
- 65.9% (29) were not familiar with *C. acutus* hatchlings or hatching time for the species;
- 100% (44) considered fish to be the main food item for *C. acutus* (birds, amphibians, reptiles and mammals also mentioned as prey items); and,
- 20.4% (9) also named humans as potential prey for *C. acutus* in the area.

There was a significant positive correlation between age of interviewee and knowledge about *C. acutus* ecology (Spearman: 0.52; Chi-square p-value: 0.0001) and its offspring (Spearman: 0.38; Chi-square p-value: 0.0001), but the correlation between age and knowledge of nests was much weaker (Spearman: 0.04; Chi-square p-value: 0.0001).

One of the 59 interviewees had been attacked by *C. acutus* in the last 10 years, and 4 attacks on livestock (pigs, cattle) had been recorded in the last 50 years.

Although most interviewees indicated that they had sighted *C. acutus*, day and night surveys did not result in any evidence of the species occurring in the areas surveyed, which comprised around 33% of the total swamp perimeter.

Crocodylus acutus was reported as abundant in Colombia up to 1928, when hunting and skin commercialization began its rise (Medem 1981; Barahona *et al*. 1996). In 1950 the species was reported to be commercially extinct (Barahona *et al*. 1996), and between 1970 and 1980, Medem (1981) reported local extinction in areas such as Fuerte, Totuguilla and San Bernardo Islands, as well as in some mainland areas of the Colombian Caribbean region. Medem (1981) also reported the existence of *C. acutus* in the Zapatosa Lagoon complex and its tributaries (Magdalena and Cesar Rivers). In the last documented report of *C. acutus* in the area, Barahona *et al*. (1996) found tracks in nearby tributaries (eg Limón and Los Frailes Creeks) but did not sight any individuals.

The current study did not record any sightings or other traces of *C. acutus*, due either to a very low density of the species in the area or local extinction in broad sectors of the lagoon complex. Interviews indicated that there are few sightings, and they are outside of the principal swamp areas, supporting the hypothesis of partial loss of the *C. acutus* population within the lagoon complex. Relative to *C.c. fuscus*, which also inhabit the area (Balaguera-Reina 2012), there was little knowledge about *C. acutus* ecology, and it lay mostly with the oldest interviewees (46-60 and >60 years).

It is necessary to implement conservation and management programs in this important lagoon complex, focused on population restoration and restocking. Currently there are no Protected Areas or management programs for *in-situ* conservation of biodiversity and habitats in the zone.

Acknowledgements

I thank Charry Narváez Ltda and the work of the Paraíso Farm, the Environmental Regional Agency (CORPOCESAR) headquarters at Chimichagua, German Payan and Wilson Ascanio for assistance with this project. I also thank the editor for his help in improving this manuscript.

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North America

USA

2012 SUMMER BBQ FOR CROCODILIAN CONSERVATION RAISES RECORD AMOUNT. The 2012 Summer BBQ for Crocodilian Conservation was held on 30 June 2012 at the Reptile World Serpentarium in St. Cloud, Florida, USA, with proceeds benefitting the critically endangered Siamese crocodile. The bulk of the funds raised at the event will be directed towards the Cambodian Crocodile Conservation Program (CCCP), co-founded by Fauna & Flora International (FFI), the Royal Government of Cambodia, and local communities to save the Critically Endangered Siamese crocodile and its globally important wetlands. The total amount raised was $US9000, a record for the 4-year-old grassroots fundraiser.

Despite the extreme heat and humidity that followed the torrential rains Florida experienced just days before, the BBQ event attracted 120+ attendees. It was hosted by George Van Horn and organized and sponsored by Flavio Morrissiey, Bruce Shwedick, Shawn Heflick, Curt Harbsmeier and Colette Adams, with special guest organizer, Lonnie McCaskill. Joe Wasilewski (CSG member and frequent Nat Geo contributor) was on-site throughout the event and served as auctioneer.

Courtesy of George Van Horn, event-goers were allowed to view all of the Serpentarium's exhibits and were even treated to a demonstration of venom extraction carried out by George and his wife, Rosa. Attendees were also able to interact with juvenile Siamese crocodiles, courtesy of Gator Adventure Productions and Dragonwood Conservancy. Presentations were aslo conducted by Reptile Discovery Programs and the Crocodilian Conservation Center of Florida, Inc.

Megan Terry was on-hand to oversee both the silent and live auctions, and she kept outstanding track of donations, donors and proceeds. Rapport between Shawn and Joe made for a very entertaining and profitable live auction. Everyone enjoyed great food (grilled and prepared on site!) and camaraderie while bidding on some unique items. Outstanding auction items were donated by businesses and individuals throughout Florida and other parts of the country. A limited edition bronze crocodile statue was presented to the Van Horn's from the organizers in appreciation of their generous hospitality.

Eight thousand dollars from the event proceeds is being sent to FFI and will be used to carry out facets of an innovative *in-situ* program that addresses both the immediate and underlying threats to Siamese crocodiles, using a combination of education, population capacity building, applied research, captive breeding, and development of more sustainable livelihoods. Per donor specification, $1000 will be set aside to conduct a genetic evaluation of captive Siamese crocodiles currently held in North America.

We want to thank all of the individuals and institutions who supported this fundraising event, including but not limited to: George and Rosa Van Horn (Reptile World Serpentarium); Flavio Morrissiey; Curt Harbsmeier; Colette Adams; Shawn Heflick; Bruce Shwedick; Lonnie McCaskill; Joe Wasilewski; Megan and Nick Terry; David Kledzik; Matt Shirley; Tom Crutchfield; Tim Scott; Greg Lepara; Don Kaye; Terry Cullen; Wayne Hill; Tara Johnson; Dr. Brady Barr and Mei Len Sanchez-Barr, in memory of Joe Abene; Darren Liebman; Gator Adventure Productions (Orlando, FL); Shawn Heflick Enterprises, Inc. (Palm Bay, Florida); Crocodilian Conservation Center of Florida, Inc. (Frostproof, Florida); Reptile Discovery Programs (Plant City, Florida); St. Augustine Alligator Farm, John Brueggen; Wildlife Discovery Center at Elawa Farm, Rob Carmichael; Alligator Adventure, Ken Alfieri; Black Hills Reptile Gardens, Terry Phillip; Busch Gardens, Mike Malden; Indigenous Arts (St. Augustine, Florida); Chelonia Eco-Associates, LLC; Madras Crocodile Bank Trust; Colin Stevenson; Houston Zoo; Jacksonville Zoo, Dino Ferri; Louisville Zoo, Gary Johnson; Utah's Hogle Zoo, Liz Larson; Gladys Porter Zoo, Darlene Campbell; Memphis Zoo, Steve Reichling; Zoo Miami, Steve Conners; Santa Barbara Zoo, Lindsay Koch; Dragonwood Conservancy (Eustis, Florida); International Palms Resort; ZooMed; Bone Clones, Inc.; Underground Reptiles; Ben Siegel Reptiles; Expedition Cargo; Didgeridoo Down Under (Tampa, Florida).

From left: Lonnie McCaskill, Curt Harbsmeier, Shawn Heflick, Colette Adama, Bruce Shwedick, Flavio Morrissiey (sitting). Photograph: B. Shwedick.

Flavio Morrissiey *(flaviomorrissiey@gmail.com),* Bruce Shwedick *(bshwedick@aol.com),* Shawn Heflick *(sheflick@aol.com),* Curt Harbsmeier *(charbsmeier@hdalaw.com),* Colette Adams *(cadams@gpz.org)* and Lonnie McCaskill *(lonnie@expeditioncargo.com).*

AIRBOAT CAPTAIN ARRESTED FOR FEEDING ALLIGATOR THAT BIT OFF HIS HAND. Wallace "Wally" Weatherholt, 63, the Everglades City airboat captain whose left hand was bitten off by a 9' American alligator (*Alligator mississippiensis*) last month, was arrested in July on a charge of unlawful feeding of an alligator, a second-degree misdemeanor punishable by up to 60 days in jail and a $500 fine. Between January 2011 and May 2012, 6 people were warned and 13 were cited in Florida for feeding or enticing alligators.

Source: *Naples Daily News, 29 July 2012 (www.naplesnews.com/news/2012/jul/29/airboat-captain-whose-hand-was-bitten-alligator-ar).*

East and Southeast Asia

Philippines

SUCCESSFUL BREEDING OF *CROCODYLUS MINDORENSIS* UNDER SOFT RELEASE CONDITIONS. Following the release of 3 captive-bred adult *C. mindorensis* into a large swamp area at Pag-asa Farms in Davao del Norte, Mindanao [CSGN 30(2): 10-12] on 19 July 2009, 5 of the 7 remaining breeders intended for release have bred in natural

settings. These crocodiles had been maintained in semi-wild conditions without any supplementary feeding since they were transferred from Palawan Wildlife Conservation Center (PWRCC; formerly Crocodile Farm Institute) in Palawan and the Silliman University Crocodile Breeding Facility in Dumaguete.

Nine clutches from five breeding females were recorded between 8 April 2009 and 2 July 2012. Average clutch size is 25.4 eggs (range 8 to 33). Based on 229 eggs produced, 55.9% were definitely fertile, and hatching success was 54% of fertile eggs. Incubation under natural conditions was 95-100 days.

On 22 March 2012 an average sized (6-7') adult female was observed laying eggs. The nest mound was 160 cm in diameter and 30 cm high. The average temperature of the nest mound was 29.2°C (measured using laser thermometer).

At the time of hatching of this clutch, two other females (#5412 and 5415) displayed nest guarding behaviour, and prevented the female (#6110) that had been observed laying from caring for her hatchlings. Two more clutches of eggs were then noticed in the nest mound. The first clutch (N= 31 eggs) was in a nest chamber some 20 cm into ground, but with some eggs sitting within the bottom 10 cm of the nest mound (Fig. 1). The second (N= ~30) and third clutches (N= 15) were laid in a similar fashion, in separate egg chambers. It is unclear why the same mound was used, as there was sufficient nest material and space available.

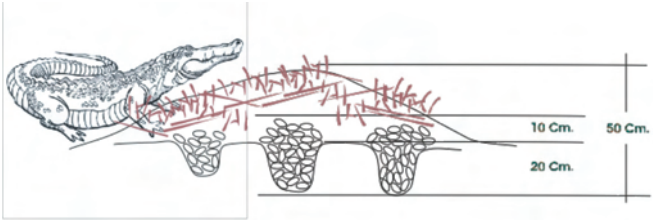

Figure 1. Diagrammatical representation of the three *C. mindorensis* nests laid in the same mound in 2012.

Figure 2. Adult female Philippine Crocodile and hatchlings (5) produced under semi-wild conditions at Pag-asa Farms, (a JKM-PAWB-Silliman University Project), located in Kapalong, Davao Del Norte, Philippines.

In captivity, different females laying their eggs in the same nesting mound has been recorded with *C. porosus* (C. Manolis, pers. comm.). The possibility that the clutches represent "staged" nesting by the one female (eg see Blake 1987) cannot be totally rejected, but the behaviour of three different females, the sizes of the clutches, and the hatching dates, suggest that this is unlikley to be the case. We believe that three different females were involved.

The 12 hatchlings that emerged from the first nest were recovered on 2 July 2012 (Fig. 2), together with 7 dead embryos and 12 infertile eggs.

Progeny from this semi-natural facility will be released into the wild at Siargao Island Protected Landscape and Seascape (SIPLAS). This is part of the benign introduction of *C. mindorensis* being initiated under the Crocodylus Porosus Philippines Inc. (CPPI) Crocodile Conservation Program.

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Australia and Oceania

Australia

MONSTER FOSSIL CROCODILE FOUND IN QUEENSLAND. Scientists have found what they believe to be the front lower jawbone of an ancient "monster" crocodile at a remote station in northwest Queensland. They estimate the extinct saltie could have been more than 12 m long. The fossil was found during a dig along the Leichhardt River, near Floraville Station, on 10 July 2012, by Masters student Bok Khoo from the University of New South Wales.

Althouh no teeth were found, the size of the sockets (35-40 mm wide) suggests very large teeth. It is believed that the ancient crocodile may belong to the genus *Pallimnarchus*, an extinct mekosuchine crocodylian from the Pliocene and Pleistocene period (1-2 million years ago). Radiometric dating will confirm the age, but at this stage it is thought to be *Pallimnarchus pollens* - the largest species in the genus. Its ranged widely, down the east coat of Australia to where Brisbane lies today, and inland to Lake Eyre.

Source: *Samantha Healy, The Sunday Mail (Qld), 5 August 2012 (http://www.heraldsun.com.au/news/national/croc-and-awe-over-dino-mite-fossil/story-fndo45r1-1226442903133).*

LONE FRESHIE FOUND IN SOUTHERN QUEENSLAND. Residents of Mundubbera, a small town west of Maryborough, in Queensland, were shocked to hear of the discovery of a 2 m long Australian Freshwater Crocodile (*Crocodylus johnstoni*) more than than 1000 km south of the species' "comfort zone".

Government officers conducting lungfish research came across the mature male crocodile while "electrofishing" in Jones Weir on 9 August 2012. Long-time residents of the area had never seen anything like it, but did recall rumours about 15-20 years ago about larrikin fishermen returning from the Gulf of Carpentaria with baby crocodiles and releasing them into the Burnett River. Whether this animal had grown up in the area, and gone unnoticed for a long period of time, remains unknown. The species is known to occur in the Bowen River, about 700 km to the north of Mundubbera.

This finding comes on the heels of the sighting of a large Saltwater crocodile (*C. porosus*) in the Mary River, about 250 km north of Brisbane, and about 400 km south of the species' "normal" distribution. Wildlife rangers recently abandoned attempts to catch the elusive crocodile until the weather warmed up.

Source: *Peter Hall, The Courier-Mail, 10 August 2012*.

"CHARLENE" THE CROCODILE TO BE LEFT TO CHILDREN IN WILL. Most people leave their children property or family heirlooms in their wills. John Casey, a canegrower from the O'Connell River near Mackay, Queensland, has decided that his adult children should inherit "Charlene", a 3 m long Saltwater crocodile (*Crocodylus porosus*).

But Charlene is not just any old crocodile! She has been part of the family since John was a toddler, and his father, Alf Casey, brought her home as a hatchling 48 years ago. Charlene became well-known around north Queensland, often accompanying the Casey family on holidays or for day trips.

In 1986 the family came close to losing Charlene (2 m long at that time) when she "accidentally" bit Alf, who subsequently lost his arm to the elbow as a result. When Alf died recently, Charlene was left to John, who had to battle with the Queensland wildlfe authorities about two years ago for permission to keep her. Although Charlene was eventually "returned" to the family, the battle to keep her continues, with the Caseys' permit to be reviewed again in October.

Source: *Samantha Healy, The Sunday Mail (Qld), 8 July 2012*.

South Asia and Iran

India

HUMAN-CROCODILE CONFLICT SYMPOSIUM. In response to growing incidence of Human-Crocodile Conflict (HCC) in India, Madras Crocodile Bank Trust (MCBT) organised a HCC Symposium during the recent Society for Conservation Biology conference in Bangalore, India, on 9 August 2012.

The goal was to get some of the main players within India together to discuss the issue and to begin drafting a plan to address HCC in the country.

Attendees: Colin Stevenson (Director, MCBT), Ravi Chellam (Director of Research and Conservation, MCBT), Nikhil Whitaker (Curator, MCBT), B.C. Choudhury (CSG), Bavish Pandav (Wildlife Institute of India; WII), Raju Vyas (Gujurat Manish Chandi, Andaman and Nicobar Islands Environmental Team), Ajae Saxena (Addl. PCCF (Wildlife) A & N Islands), Shailendra Singh (Turtle Survival Alliance).
Apologies: Adam Britton, Brandon Sidleau

A few of the key points emerging from presentations were:

- We know the causes of HCC in India: very large and increasing human population, growing crocodile populations, less habitat available for crocodiles, dangerous practices such as bathing and washing in crocodile areas, fishing, lack of awareness of how to live with crocodiles (no knowledge of territoriality, parental care, breeding seasons and associated aggression in crocodiles, basic crocodile biology - water's edge predator), one or more generations of people simply not used to having crocodiles around.
- We recognised that HCC is a two-way street: crocodiles attacking people and their livestock, but also humans negatively impacting on crocodiles via habitat loss, accidental killing/injuring of crocodiles, removal of prey items, pollution.
- The use of waterways - recreational use versus livelihood/ essential use (washing, bathing, fishing) - influences HCC incidents more than the size of crocodile population.
- The Crocodile Attack Database is clearly a powerful tool for crocodile management.
- We have a pretty good idea of the key areas where HCC is a serious problem in India, based on Nikhil Whitaker/ MCBT HCC study in 2009.
- Bhitarkanika has an estimated population of 1646 Saltwater crocodiles, and needs assistance in developing a survey of the crocodiles, and assessment of HCC and mitigation strategies.
- Gujarat State has large Mugger populations, often within city limits. Relocation of these crocodiles is limited in efficacy, and more work is needed to address conflict in the state.

- The Andaman Islands has a good Saltwater crocodile population, but faces HCC problems that are exacerbated by a reliance on international tourism. There is a clear need for crocodile surveys, education and awareness programs, and HCC mitigation controls.
- In contrast, the Nicobar Islands have some native tribes that are able to live with crocodiles without conflict. This is a good example of 'Living with Crocodiles', and can inform education programs.
- As pointed out by B.C. Choudhury, problem crocodile programs, sustainable use (at least in some states), and eco-tourism are just some options that need to be explored.
- We have a group of people interested in pursuing a management plan/HCC protocol.

An important point is that any database remains as useful as the data entered into it. Therefore, a request goes out to CSG members to send information on known attacks to Brandon Sideleau in order that the database is able to fulfil its potential.

Ajae Saxena described the political and public pressures that Forest Departments come under when dealing with crocodile conflicts. The Andamans are struggling with the solution to growing problems with Saltwater crocodiles, and getting the balance right is vital.

Interestingly, there was a strong discussion of sustainable use as a future option. However, such a solution is a long way off - in terms of both time and policy changes.

A number of initiatives are already being discussed and proposed:

- Education/awareness program, surveys and telemetry study on *Crocodylus porosus* in the Andamans by Nikhil Whitaker and MCBT.
- Bhitarkanika *C. porosus* study by WII.
- Gujarat *C. palustris* study.
- MCBT is taking the lead on developing a HCC Working Group in India to inform and develop a protocol that addresses HCC within India.

These projects show a renewed interest in studying crocodiles in India. These studies will complement the current Gharial work being carried out by Professor Jeff Lang and MCBT.

I would like to thank all attendees for the time and effort they put into their presentations, and for their enthusiasm in taking part in this symposium.

A progress report of work stemming from this symposium will be presented at the 2013 CSG meeting in Sri Lanka.

Colin Stevenson, *Director, Madras Crocodile Bank Trust (coleosuchus@hotmail.com).*

Science

Submitted Papers

Estimating Age from Recapture Data: the Importance of Data Exploration

William E. Magnusson

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Summary: Preliminary data exploration can avoid many common statistical mistakes, and this applies as much to complex analyses, such as those used to analyze growth, as to conventional statistics. Here I show that the use of simple exploratory graphs allows us to better evaluate the assumptions of growth analyses. A graph of growth rate on size allows evaluation of feasible model parameters and avoids inclusion of unnecessary tests. Plotting growth trajectories of individuals with more than one recapture allows evaluation of the need to include a hierarchical design with individual-specific parameters. If one measure will be used to predict another, plotting the relationship between those variables will help select the correct error structure. Comparing known measures to model predictions allows evaluation of the necessity to include extra parameters in the model. These simple steps may obviate the need for over complex analyses, and improve communication between authors and readers.

Introduction

The massive increase in computational ability has led to the use of complex models that would not have been possible even a decade ago. While the benefits of complex models are undeniable, they also have some undesirable features, such as increased number of assumptions, instability associated with the ratio of parameters estimated to the amount of data available, and the inability of readers to understand the mathematics. Zuur *et al*. (2010) outlined the importance of data exploration, mainly through inspection of graphs, to evaluate model assumptions. However, editors and reviewers frequently do not require that authors present such graphs, and results of models may be presented with no empirical justification. Some of the most frequently used techniques in ecology, such as Discriminant Function Analysis, Canonical Correspondence Analysis, and Redundancy Analysis, use graphs that present the way data would be if the model was correct, rather than comparing the model to data. Confidence intervals are based on model assumptions and may be difficult to interpret without comparison to data.

Methods

Here, I will use a paper on crocodilian growth to illustrate why simple exploratory graphs may help communication. This is not a criticism aimed specifically at that paper, which presents important considerations for data analysis, and the authors made available most of the data necessary to interpret the study as supplementary material. However, it is useful to illustrate my points because the paper presents only graphs of model predictions, with no exploratory data analysis to justify the decision to use complex models. The growth models used belong to the Richards family of growth models and are used for a wide range of vertebrates (Andrews 1982). Here I will show that preliminary data exploration of the type suggested by Zuur *et al*. (2010) can help model selection for studies of growth, and make the results understandable to a much larger audience.

Eaton and Link (2011) used a Bayesian framework to analyze growth of *Osteoleamus tetraspis*, a small African crocodile. Here I will focus on the results of the analyses used to make conclusions about the shape of the growth rate on length relationship, size at hatching, and the relationship between head size and total length. Extremely complex analyses were used for each, and I will consider each in turn.

Results

Growth rate on size

Studies of crocodilian growth generally have been based on the growth rate on size relationship because it is difficult to obtain data for other methods in the field. Most researchers have assumed that crocodilians have a sigmoidal age on size relationship that can be modeled by one of the curves in the Richards family (Brisbin *et al*. 1987; Moulton *et al*. 1999), but some species have growth rate on size relationships that do not conform well to curves in the Richards family (Magnusson and Sanaiotti 1995). Different curves within the Richards family have different growth rate on size relationships (Andrews 1982). Eaton and Link (2011) compared two curves from the Richards family, the logistic and "von Bertalanffy" models. The von Bertalanffy models growth rate on mass, and the model called von Bertalanffy is really the monomolecular, which assumes a linear decrease in growth rate with length. The data provided by Eaton and Link (2011) clearly indicate that a linear decrease in growth rate with length (Fig. 1) fits the data better than a convex (logistic) model, though a convex model cannot be ruled out. Visual inspection also allows evaluation of whether the relationship might be better modeled by a relationship not available within the Richards family (eg Magnusson and Sanaiotti 1995). The four parallel Markov chains of length 4.5 million and the 18.5 hours of computer time used by Eaton and Link (2011) were not necessary to obtain this much more general result using the largest computer that has ever existed (the human brain) and a simple exploratory graph.

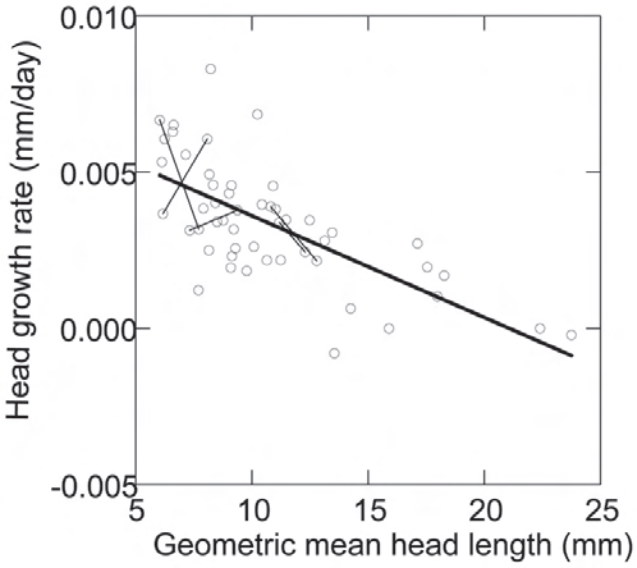

Figure 1. Relationship between head length growth rate and geometric-mean head length during the growth period for *Osteoleamus tetraspis*. Data are from Appendix A of Eaton and Link (2011), Ecological Archives A021-110-A1). Fine lines join points for animals with multiple recaptures. The thick line represents a least-squares regression of growth rate on mean head length.

Size at hatching

Sizes of known-age animals, especially animals near reproductive maturity, is the gold standard to evaluate size-age relationships, but these data are rarely available, and are usually so limited that they can only be used for rough evaluation of the utility of the curves (eg Magnusson *et al*. 1997). Eaton and Link (2011) emphasized that they used data for known-age animals, but the data on known-age animals was limited to four animals known to have age zero and two animals less than a month old raised in captivity. They had head length (their measure of size) for only two animals, so they used a complex analysis involving head and body lengths of many animals to better estimate size at hatching. The head lengths of the only two known-age hatchlings that were measured were 3.05 cm and 3.44 cm. The incredibly complex analysis to increase confidence in the estimated mean head size at hatching returned an estimate of 3.36 cm with confidence interval 3.06-3.71. That is, one of the only two measurements made was outside the confidence interval for the mean. Use of this value indicates that the model makes us lose confidence in the data, but wouldn't it be more logical to take the point of view that the data make us less confident in the model? Simply graphing the data together with the model might have made us decide to use a simpler model, such as mean size of the two measured individuals.

Even if head size at hatching is poorly estimated, it is unlikely to have much influence on estimates of age at first reproduction. However, inclusion of many more parameters to refine that estimate may result in an unstable model. It may be worthwhile doing a sensitivity analysis first and using only

rough estimates for uninfluential parameters to avoid model instability.

Extent of individual variation

Growth rates of crocodilians often vary systematically among individuals (Webb *et al*. 1983; Magnussson and Sanaiotti 1995). Therefore, a curve based on means might not represent any animal well, and will systematically underestimate mean age at a given size. Therefore, the hierarchical design suggested by Eaton and Link (2011) would be the preferred model for *Crocodylus johnstoni* and *Caiman crocodilus* [see graphs in Webb *et al*. (1983) and Magnussson and Sanaiotti (1995)]. However, this model is extremely complex and requires estimation of more parameters. Is it necessary for *O. tetraspis*? We can evaluate this by connecting points for individuals on the growth rate on size relationship (Fig. 1). The growth trajectories for individuals vary, but it is obvious that those individuals could not maintain their trajectories for long without attaining unrealistic growth rates. The few individuals that had trajectories almost parallel to the mean had trajectories that were almost coincident with the mean. That is, individual variation is as great as the overall variation. This pattern is very different from the principally parallel trajectories shown by *C. crocodilus* and *C. johnstoni*. Therefore, a simple exploratory graph informs that, for these data, a hierarchical model will not be accurate than one based on the mean trajectory.

Relationship between head length and total length

Eaton and Link (2011) used head length as their measure of size to estimate age, but information on minimum size at reproduction was presented as total length. Minimum size at reproduction is difficult to estimate in the field, and this is probably the most inaccurate estimate we use when evaluating age at first reproduction. Nevertheless, accepting the estimate of total length at first reproduction as realistic, we have to convert total length to head length to estimate age at first reproduction. The data provided by Eaton and Link (2011) indicate that this relationship is imprecise (Fig. 2). However, simply including a symmetrical error term for this relationship may not be appropriate. Inspection of Figure 2 indicates that a limit regression might be more appropriate, with the upper limit indicating the inherent relationship and almost all deviations below this limit, especially for animals with head length larger than about 4.7 cm. Such a relationship is expected from what we know of the ecologically similar *Paleosuchus palpebrosus*, which loses tail scutes with age (Campos *et al*. 2010). Using a standard error structure probably will not greatly affect the estimate of mean age, but will increase the estimated error of the estimate.

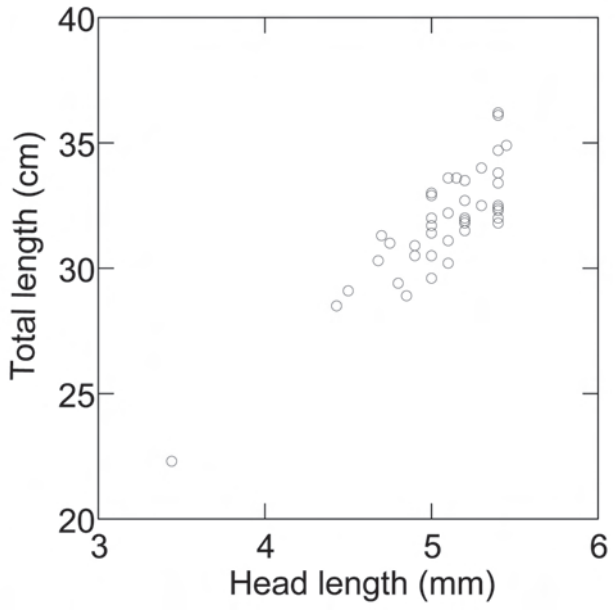

Figure 2. Relationship between head length and total length for *Osteoleamus tetraspis*. Data are from Appendix B of Eaton and Link (2011); Ecological Archives A021-110-A2).

Discussion

Does it matter? Simple exploratory graphs allow us to evaluate the assumptions of growth analyses. A graph of growth rate on size allows evaluation of feasible model parameters and avoids inclusion of unnecessary tests. Plotting growth trajectories of individuals with more than one recapture allows evaluation of the need to include a hierarchical design with individual-specific parameters. If one measure will be used to predict another, plotting the relationship between those variables will help select the correct error structure. Comparing known measurements to model predictions allows evaluation of the necessity to include extra parameters in the model. These suggestions for growth models are a simple extension of the recommendations of Zuur *et al*. (2010). Keeping our models as simple as possible will help communication. The standard procedure of nonlinear least-squares estimation of the parameters for the von Bertalanffy (monomolecular) model (Eaton and Link 2011: equation 1), and assuming a normal least-squares error structure for the relationship between head length and total length (which I assume was used by Eaton and Link 2011), I estimate the mean age of females at 100 cm total length to be 15.6 years, very different from their estimate of median age of reproduction of 9 years. I cannot be sure, but suspect that the difference results mainly form inclusion of unnecessary parameters in their model.

As models become more complex, it becomes more difficult for readers to evaluate assumptions and make empirical evaluations. Providing the raw data is an important step towards improving reporting of results, but papers that provide only description of the model and its prediction will be hard to evaluate, and most readers will probably not have time to download the data and do their own analyses. Therefore, it is important that editors and reviewers require reporting of data exploration protocols, such as those recommended here and by Zuur *et al*. (2010), and that these are readily accessible to readers, even if only in the form of electronic appendices.

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Motina (SIC) Mistake Prompts Genus-Group Names *Motinia* Gray, 1844, and *Molinia* Gray, 1862, Review

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The letter-T subgenus *Motinia* Gray, 1844, which is a different spelling from the letter-L genus *Molinia* Gray, 1862, is not even mentioned in the synonymy in Ernst *et al*. (1999), nor in its text. This is a surprise, because the 1844 T-spelling would be expected in a Society for the Study of Amphibians and Reptiles species account. Recently, someone on the internet spelled it *Motina* in error, and I looked it up to remind myself what the *Motinia* and *Molinia* (and *Palinia*) nonsense was all about. The alternative L-spelling *Molinia* genus was employed in Gray (1862, 1867, 1872, 1873, 1874a), and the italicized plural Moliniae (meaning the two species of *Molinia*) was used by Gray (1874b).

In its original 1844 subgenus form, *Motinia* was monotypic, and meant what we call *Crocodylus acutus* today. However, more than a decade later, the genus *Molinia* Gray, 1862, included today's *C. acutus* and also *C. intermedius* in it, and remained that way in Gray (1867, 1872, 1873), and indirectly in Gray (1874b) also. Despite the change in spelling and the addition of *C. intermedius*, it was always clear to Andy Ross and me that the two genus-group names *Motinia* and *Molinia* were in fact the same thing. Thus, in the Ernst *et al*. (1999) synonymy, the entry "*Crocodilus americanus*: Gray 1844:60" could have said "*Crocodilus* (*Motinia*) *americanus*: Gray 1844:60" but, technically speaking, Gray (1844) did not punctuate it that way. Rather, on pages viii and 60, he actually wrote the binomial combination as merely *Crocodilus americanus*, without any subgenus inserted within it. In hindsight, the Ernst *et al*. (1999) entry for Gray (1844) was highlighting that the species-group name was the masculine *Crocodilus americanus*, as opposed to the subsequent later combinations *Molinia americana* Gray, 1862, and *Molinia acuta* Gray, 1874[a], both of which have feminine species-group name endings (*americana* from *americanus*, *acuta* from *acutus*).

Neither *Motinia* nor *Molinia* ever included the Cuban crocodile, because in 1844 it was in the subgenus *Palinia* Gray, 1844, and it was in the genus *Palinia*, as the combination *P. rhombifer* (masculine ending) in Gray (1862), and as *P. rhombifera* (feminine ending) in Gray's (1867, 1872, 1873) subsequent listings. Similarly, neither *Motinia* nor *Molinia* ever included the Morelet's crocodile, because in 1844 it had not yet been discovered, and in Gray (1862, 1867, 1872, 1873) it was added as the only other species in *Palinia*.

The change in spelling from *Motinia* to *Molinia* was never explained by John Edward Gray himself, but approximately a century later, Loveridge (1957) expressed the opinion that *Motinia* had been an accidental misprint in Gray (1844), and that this error was subsequently "corrected to *Molinia* by Gray, 1862". However, on page 272 in Gray (1862), what actually happened is that the L-spelling *Molinia* was simply employed where the T-spelling *Motinia* was expected. After that, the L-spelled *Molinia* got repeated in Gray's later works. The American crocodile's species account treatment in Ernst *et al*. (1999) slightly disagreed with Loveridge (1957), because the L-spelling *Molinia* was not actively recognized by Loveridge (1957), who in the chronological body of his genus-group level history listed only "1844 *Motinia* Gray, Cat. Tort. Croc. Amphis. Brit. Mus., p. 60. Type by monotypy: *Crocodilus americanus* Schneider = *C. acutus* Cuvier" in his synonymy of *Crocodylus* Laurenti. The L-spelling *Molinia* was relegated in Loveridge (1957) to a footnote from Gray's letter-T *Motinia* entry dated 1844.

It makes sense to me that if the T-spelling was actually the original, then *Motinia* should enjoy nomenclatural precedence

over its subsequent spelling. Today, I believe that this was the case, because *Crocodilus americanus* was placed alone and by itself in a named subsection of *Crocodilus* that Gray (1844) called *Motinia*. Thus, in my opinion, Loveridge's (1957) preference for *Motinia* Gray, 1844, as opposed to the corrected spelling *Molinia* Gray, was an intellectual improvement on Boulenger's (1889) earlier "*Crocodilus*" (= *Crocodylus* Laurenti) synonymy which did not mention the T-spelling *Motinia* at all, but rather merely recognized the L-spelling *Molinia* as originating in Gray (1862). Technically speaking, Boulenger's (1889) *Crocodilus americanus* synonymy listed "*Crocodilus americanus* Gray, Cat. Tort. &c. p. 60 (1844)" and then separately "*Molinia americana*, Gray (1862, 1867 and 1872)". The treatment in Ernst *et al*. (1999) coincides closely with Boulenger (1889), because in the 1999 SSAR's American catalog, and also in George Albert Boulenger's 1889 British Museum catalogue, the T-spelling *Motinia* was not included.

It is clear that *Motinia* Gray, 1844, and *Molinia* Gray, 1862, are synonyms of each other, and that the L-spelling functioned as an emendation (presumably a correction) of the T-spelling. Thus, in agreement with Loveridge (1957), I today assert that Carl Ernst *et al*. (1999) was deficient, and should have listed "*Crocodilus* (*Motinia*) *americanus*" in the SSAR's American crocodile species account. Note that in an exactly equivalent set of circumstances, Ross (1998) listed "*Crocodilus* (*Palinia*) *rhombifer*: Gray 1844:60" in the synonymy of the Cuban crocodile.

Similarly correct is "*Palinia* ? *Moreletii*: Gray, 1862:271. New combination" in the Ross (1987) synonymy of *Crocodylus moreletii*, because "*Palinia ? Moreletii*" is how Gray (1862) wrote it, and there was no Morelet's crocodile content in Gray (1844).

The combination *Molinia intermedia* Gray, 1862, was also new, because Gray (1844) had earlier listed today's Orinoco crocodile in a different genus. However, the entry "*Molina intermedia* Gray, 1862:272" (sic) in Thorbjarnarson and Franz's (1987) same year SSAR synonymy was an accidental error, because Gray (1862) spelled the genus with an IA-ending (*Molinia*). In J.E. Gray's crocodilians, there is no *Molina* (sic) or *Motina*.

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Persistence of Maternal and Juvenile Behaviour in African Slender-snouted Crocodiles

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When threatened, hatchling and juveniles of most, if not all, crocodilian species, vocalize. These high pitched vocalizations frequently elicit a defensive response on the part of nearby male or female parents (or other adults). This behavior persists for as long as a year or more on the part of both adults and juveniles (Lang 1989; Staton 1978). Here, I report on observations of juvenile vocalizations and female defensive responses in African Slender-snouted crocodiles [*Crocodylus* (*Mecistops*) *cataphractus*] at a far older age than would be expected.

In the course of capturing a group of *C. cataphractus* held at Zoo Miami (Miami, Florida) two of four specimens emitted juvenile distress calls while being restrained. They are male siblings aged 21 years. However, they are severely stunted being only 165 and 170 cm total length due to inadequate care at another facility. Their mother, a wild-caught animal that originated in Liberia, was imported to the USA in 1940. She is estimated to have hatched in 1934, making her approximately 77 years old (Groves 2012). Her most recent offspring hatched in 2007. The mother is housed in a pen which abuts that of the small males, but is nearly 100% visually separated from them. Upon hearing the distress calls the female began to hiss loudly. On two occasions she struck the dividing barrier aggressively. She eventually positioned herself so that she could see into the adjacent pen through a small opening in the barrier. These observations were made on 21 December 2011.

Figure 1. Female African slender-snouted crocodile at Zoo Miami, estimated to be 77 years old.

On 21 June 2012 the male siblings were restrained again in preparation for shipment. All four of them emitted distress calls as each was captured in sequence. The female parent's reaction was much more subdued during this episode. She was submerged in her pool at the start of the procedure and surfaced when the first vocalization was emitted. She surfaced each time a vocalization could be heard, faced the males' pen, but never left the pool or acted aggressively. There was no discernable difference in the tone of the vocalizations between the two episodes, so it is unclear what caused the change in behavior. It was apparent, however, that the vocalizations were audible to the female when she was submerged.

Staff were surprised that crocodiles at 21 years of age would still vocalize in a manner characteristic of much younger specimens. The reaction of the mother is not surprising, but of note because of her advanced age. An informal query on this subject was posted on the Association of Zoos and Aquariums Crocodilian Taxon Advisory Group listserve. There were a number of interesting responses detailing observations of both captive and wild animals. Respondents reported observations of distress calls in large adult *Alligator mississippiensis* (I. Dupont, pers. comm.) and *C. niloticus* (J. Walkowich-Brueggen, pers. comm.) in the wild. Captive *Tomistoma schlegelii* and *Paleosuchus palpebrosus* have been heard making distress calls at 4 and 6 years of age respectively (B. Muscher, pers. comm.).

Staton (1978) examines possible explanations for crocodilian distress calls besides eliciting parental protection. This includes warning of nearby conspecifics of danger, with the possibility that the behavior is actually altruistic when it occurs after parental care has ceased. Neil (1971) compares crocodilian distress calls to the "shrill cry" emitted by some frogs, birds and rodents when seized by a predator. This may sometimes shock and disorient the predator to the point that prey may be released and escape.

In the examples noted above any of these reasons for the vocalizations could apply. The fact that this behavior persists beyond the hatchling/juvenile age in this, and apparently other species, may indicate that it endures throughout the lifespan of all crocodilians. The same is possibly true of the defensive reaction of adults to the distress calls.

Acknowledgements

I thank the Ectotherm staff of Zoo Miami for assistance in making observations and also the many e-mail respondents who provided personal observations. I also thank John Groves for providing references and reviewing the manuscript.

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Hugli Gavial Returns to Endangered

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As recently established by Ghosh (2009), and as reported by Mitra (2009) in the Times of India newspaper, and also in the Manolis (2009) digest of Mr. Mitra's article, the population

status of the Hooghly (Hugli, Hoogli) River Gavial (Gharial) needs to be changed from Presumed Extinct (as it was in 2007) to newly (in 2008-2009) become again merely Severely Endangered. This is exciting good news, and an opportunity for the CSG to get involved. This particular locality is of taxonomic importance because many or all of the very earliest scientific specimens of Asian or Gangetic *Gavialis*, the true gavial (with a ghara), originated from the wild through the seaport at Calcutta (Kolkata), West Bengal, India, located on the eastern bank of the River Hooghly, which is Ganges (Ganga) water.

Not explained in the sources above is the historical distribution of *Gavialis gangeticus* in this river in say, for example, the year 1746. Only *Crocodylus porosus* is recorded by Sanyal *et al*. (1995) for the Hugli River downstream from Kolkata, but we today ask the theoretical question of how far upriver from Calcutta would a person have had to travel in a small boat in 1746 to find a Gharial nest that was hatching (or had just recently hatched), such as the hole in the sand that produced three neonate specimens (in alcohol) in London, England.

One of the three neonate *Calcutta gavials* was illustrated by George Edwards (1756) in his excellent plate 19, parts of which are reproduced in our Figure 1, where the lateral view (Fig. 1C) shows the normal dentition erupted, and the dorsal view (Fig. 1A) we interpret as showing the egg-tooth (or "caruncle") still attached.

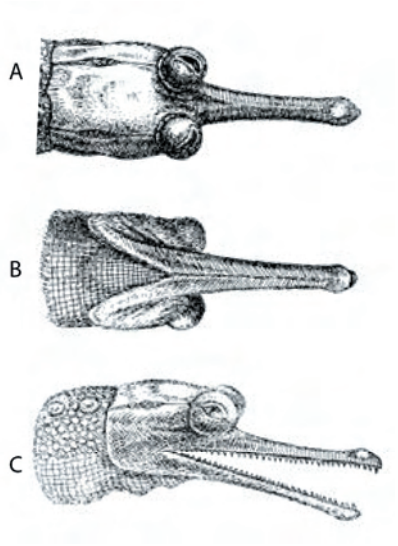

Figure 1. Slightly modified from Edwards (1756), three views (A= dorsal, B= ventral, C= lateral) of the head of a Hooghly Gharial.

Lastly the ventral view (Fig. 1B) shows the mandibular symphysis extending all the way to a level considerably behind the eyes. Assuming that it is accurately portrayed, this depicted posterior extent of the lower-jaw symphysis is the extreme of its kind of variation in the hatching and post-hatching living crocodilian taxa. We note that the plate 9, fig. 1 ventral view of the head of a young Gharial in Rathke (1866) has its symphysis extending to approximately the level of the front of the eyes, and we attribute this difference to ontogenetic variation, with Heinrich Rathke's specimen being more mature than our Figure 1 example.

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Recent Publications

Lenzen, M., Moran, D., Kanemoto, K., Foran, B., Lobefaro, L. and Geschke, A. (2012). International trade drives biodiversity threats in developing nations. Nature 486: 109-112.

Abstract: Human activities are causing Earth's sixthmajor extinction event - an accelerating decline of the world's stocks of biological diversity at rates 100 to 1000 times pre-human levels. Historically, low-impact intrusion into species habitats arose from local demands for food, fuel and living space3. However, in today's increasingly globalized economy, international trade chains accelerate habitat degradation far removed from the place of consumption. Although adverse effects of economic prosperity and economic inequality have beenconfirmed, the importance of international trade as a driver of threats to species is poorly understood. Here we show that a significant number of species are threatened as a result of international trade along complex routes, and that, in particular, consumers in developed countries cause threats to species through their demand of commodities that are ultimately produced in developing countries. We linked 25,000 Animalia species threat records from the International Union for Conservation of Nature Red List to more than 15,000 commodities produced in 187 countries and evaluated more than 5 billion supply chains in terms of their biodiversity

impacts. Excluding invasive species, we found that 30% of global species threats are due to international trade. In many developed countries, the consumption of imported coffee, tea, sugar, textiles, fish and other manufactured items causes a biodiversity footprint that is larger abroad than at home. Our results emphasize the importance of examining biodiversity loss as a global systemic phenomenon, instead of looking at the degradingor polluting producers in isolation. We anticipate that our findings will facilitate better regulation, sustainable supply-chain certification and consumer product labelling.

Kanwatanakid-Savini, C., Pliosungnoen, M., Pattanavibool, A., Thorbjarnarson, J. and Platt, S.G. (2012). A survey to determine the conservation status of Siamese crocodiles in Kaeng Krachan National Park, Thailand. Herpetological Conservation and Biology 7(2): 157-168.

Abstract: The Siamese Crocodile (*Crocodylus siamensis*) is one of the most endangered crocodilians in the world, and wild populations throughout Southeast Asia have precipitously declined over the last 50 years. Although initially feared extinct in Thailand, surveys in 2001 located a remnant population of *C. siamensis* in Kaeng Krachan National Park (KKNP), an extensive (2915 km^2) protected area along the Thai-Myanmar border. Our objectives were to assess the conservation status of *C. siamensis* populations within the park, determine if reproduction is occurring, and develop conservation recommendations based on these findings. We used a combination of nocturnal spotlight counts, track and sign surveys, and village interviews to census crocodile populations in KKNP from 2009-2011. Interview data suggest crocodiles occasionally enter Kaeng Krachan Reservoir, although we observed none during spotlight counts. No evidence of crocodiles was found on the Mae Pradone River. We recorded 10 detections of crocodile sign (tracks and scat) alongthe Petchburi River, although overall detection rates were low (<0.30/km). We found three nests along the Petchburi River from 2009-2011. Differences in mean egg width among clutches suggest one to three females nested. Clutches were considerably larger than those reported from other wild populations, but contained only non-viable eggs, possibly due to an insufficient number (or complete absence) of males in the Petchburi River. Collectively our survey data suggest at least 4, and perhaps as many as 6 non-hatchling *C. siamensis* inhabit KKNP. The viability of this small population is doubtful and without direct conservation action, extinction appears inevitable. To avoid this fate, the existing population should be augmented using crocodiles obtained from commercial farms in Thailand.

Romão, M.F., Santos, A.L.Q. and Lima, F.C. (2012). Skeletal anatomy of the pectoral girdle, stylopodium and zeugopodium of *Caiman latirostris* (Daudin, 1802) (Crocodylia: Alligatoridae). International Journal of Biology 4(4): 40-45.

Abstract: The development of the skeleton can be better understood through new discoveries, using as reference tissue that is in a dynamic process of formation and resorption. This study used a young adult male specimen of *C. latirostris*, 1.50 m in length, belonging to the collection of the Wild Animal Research Laboratory of the Federal University of Uberlândia, fixed in 10% formol. The specimen's skin, viscera and pectoral girdle, stylopodium and zeugopodium bone muscles were removed, and the bones were identified, recorded in photographs taken with a digital camera, and described. The findings demonstrate that the characteristics of the skeletal anatomy of the pectoral girdle, stylopodium and zeugopodium of *C. latirostris* resemble those of its ancestors and extend to the other crocodilians, since they exhibit inter- and intraspecific behavioral similarities.

Brien, M.L., Webb, G.J., Gienger, C.M., Lang, J.W and Christian, K.A. (2012). Thermal preferences of hatchling saltwater crocodiles (*Crocodylus porosus*) in response to time of day, social aggregation and feeding. Journal of Thermal Biology (dx.doi.org/10.1016/j.jtherbio.2012.08.003).

Abstract: Three month old hatchling *C. porosus* with data loggers in their stomachs were placed in thermal gradients, in isolation (N= 16) and in groups of 4 (N= 8 groups; 32 individuals). Mean T_b and variation in T_b (SD) was not different whether individual crocodiles in isolation were fasted or fed, or if individuals were housed in isolation (I) or in groups (G). However, individuals in isolation (N= 16) maintained slightly lower T_bs than those in groups (N=32) during the early morning (0600-1100 h). The overall mean T_b recorded for fasted individuals in the isolated and group treatments (N= 48) was 30.9±2.3°C SD, with 50% of T_bs (T_{set}) between 29.4°C and 32.6°C, and a voluntary maximum and minimum of 37.6°C and 23.2°C respectively. During the day (1100-1700 h), individuals in isolation and in groups selected the warmer parts of the gradient on land, where they moved little. Outside of this quiescent period (QP), activity levels were much higher and they used the water more. There was a strong diurnal cycle for fasted individuals in isolation and in groups, with T_b during the QP (31.9±2.09°C; N= 48) significantly higher than during the non-quiescent period (NQP: 30.6±2.31°C). Thermal variation (SD) in T_b was relatively stable throughout the day, with the highest variation at around dusk and early evening (1800-2000 h), which coincided with a period of highest activity. The diurnal activity cycle appears innate, and may reflect the need to engage in feeding activity at the water's edge in the early evening, despite ambient temperatures being cooler, with reduced activity and basking during the day. If so, preferred T_b may be more accurately defined as the mean T_b during the QP rather than the NQP. Implications for the thermal environment best suited for captive *C. porosus* hatchlings are discussed.

Fechner, R. and Schwarz-Wings, D. (2012). The muscles of the infrapubic abdominal wall of a 6-month-old *Crocodylus niloticus* (Reptilia: Crocodylia). Anatomia, Histologia, Embryologia (doi: 10.1111/ahe.12000).

Abstract: The muscles of the infrapubic abdominal wall

of crocodilians play an important role in their ventilatory mechanism. Yet the anatomy and homology of these muscles is poorly understood. To gain new insights into the anatomy of the crocodilian infrapubic abdominal wall, we dissected a specimen of *Crocodylus niloticus*. Origin and insertion of the muscles, as well as their arrangement relative to each other was examined in great detail. The findings were compared with those of other crocodilian taxa to detect potential variability of the muscles of interest. The homology of the muscles was studied by comparing the muscles of the crocodilian infrapubic abdominal wall with those of other diapsids. In *C. niloticus*, the infrapubic abdominal wall consists of four muscles: *Musculus truncocaudalis*, *M. ischiotruncus* and *Mm. rectus abdominis externus* and *internus*. The arrangement of the muscles of the infrapubic abdominal wall of *C. niloticus* is consistent with that found in most other crocodilian taxa. In some crocodilian taxa, an additional muscle, *M. ischiopubis*, is found. In the remaining diapsids, only *M. rectus abdominis* is present. The crocodilian *M. truncocaudalis, M. ischiotruncus* and, if present, *M. ischiopubis* appear to be derivates of *M. rectus abdominis*; the development of those might be related to the evolution of the unique crocodilian ventilatory mechanism.

Campen, R. and Starck, M. (2012). Cardiovascular circuits and digestive function of intermittent-feeding sauropsids. Comparative Physiology of Fasting, Starvation, and Food Limitation 2012: 133-154 (doi: 10.1007/978-3-642-29056-5_9).

Abstract: Turtles, squamates, and crocodiles show remarkable morphological and physiological plasticity of their gastrointestinal tract in response to feeding. They also show a remarkably complicated and diverse morphology of their cardiovascular circuitry and cardiovascular functioning. In particular, many species have the option to bypass the pulmonary (or the systemic) circulation by redirecting blood into the systemic (or pulmonary) circulation, respectively. In this chapter we review the evidence that supports a functional integration of the gastrointestinal system with the cardiovascular system. In particular the morphology of the cardiovascular circuits suggests that both systems are tightly integrated. The main hypotheses about a functional integration are: (1) increased blood flow to the gastrointestinal system may provision more blood for transport, and also possibly drives inflation of the gastrointestinal tract after feeding. (2) Central redirection of blood may play a role for digestion by balancing the blood pH during the alkaline tide. (3) The anatomy of the vascular circuits suggests that CO_2-rich blood is directed to the gastrointestinal tract to facilitate gastric acid production. We critically review the evidence and support for each of these ideas and outline avenues for future research that may ultimately help to clarify many of the contrasting ideas discussed in the literature. We conclude that the timing of shunting during digestion has not been fully explored; many important quantitative data (eg ventricle and blood volume, shunting volume) are completely missing; experimental studies are dominated by highly invasive studies with unclear effects on normal physiology; capillary filtration rate and the role of the lymphatic system have been neglected; and finally, volume compensation and compensatory shunts have largely been neglected.

Ribas, C., Damasceno, G., Magnusson, W., Leuchtenberger, C. and Mourão, G. (2012). Giant otters feeding on caiman: evidence for an expanded trophic niche of recovering populations. Studies on Neotropical Fauna and Environment 47(1): 19-23.

Abstract: As water along dirt roads in the Pantanal floodplains diminishes, aquatic fauna becomes restricted to shallow pools. At the end of the 2009 dry season, we filmed giant otters living in pools predating on yacare caimans. Such predation has not been recorded in giant otters inhabiting the Pantanal. Individual otters captured sub-adult caimans. The otters did not share the prey, but conspecifics stole it after conflicts. Caiman predation could be related to resource scarcity in these marginal environments. Information on diet and interactions of endangered populations may underestimate their trophic niche when they recover from over-hunting and expand into suboptimal habitat.

Cooper, J.E. (2012). The estimation of post-mortem interval (PMI) in reptiles and amphibians: Current knowledge and needs. The Herpetological Journal 22(2): 91-96.

Abstract: Studies on post-mortem interval (PMI or time since death estimations) in reptiles and amphibians have been sparse. Some limited information exists but this has usually emanated from the work of veterinarians and biologists and is often restricted to individual case reports or small samples. As a result, there is little that can be used reliably in forensic cases and investigators often have to depend on data from mammalian and avian studies. Work on fish, mainly directed towards promoting food hygiene, may or may not be relevant. Reptiles and amphibians present a range of challenges in terms of accurately assessing changes due to autolysis and decomposition, owing to their high variability in morphology and lifestyle. In particular, there are effects due to ectothermy, the different anatomical features of these two groups of vertebrates, the marked variation in body size of diverse taxa of reptiles and amphibians, and seasonal fluctuations in subcutaneous and internal fat content. Eggs, embryos and fetuses present particular challenges and the presence of a larval stage in amphibians is a further complication. Many basic questions remain unanswered. Specific research is needed, and this should involve both amateur and professional herpetologists. Ways in which useful information may be collated include the keeping of properly recorded accounts of changes in dead reptiles and amphibians, especially those kept in captivity or which can be carefully monitored, such as road-kills. Experimental studies are also needed, carried out in collaboration with for example pathologists.

Antelo, R. (2012). *Caiman crocodilus* (Spectacled Caiman). Homosexual behavior. Herpetological Review 43(2): 327-328.

Elsey, R.M., Mouton, E.C., Jr. and Kinler, N. (2012). Effects of feral swine (*Sus scrofa*) on alligator (*Alligator mississippiensis*) nests in Louisiana. Southeastern Naturalist 11(2): 205-218.

Abstract: Rapid spread of the introduced *Sus scrofa* (feral hog) is a major concern for many landowners and land managers due to its destructive rooting behavior which damages natural habitats. Feral Swine have also been reported as infrequent predators of *Alligator mississippiensis* (American alligator) eggs, with only 7 nests lost in 3 prior studies combined (Fogarty 1974; Ruckel and Steele 1984; Woodward *et al*. 1992). In response to increasing reports by Louisiana landowners of alligator nest losses due to feral swine, we sent a questionnaire addressing this issue to licensed Louisiana alligator farmers who are permitted to collect eggs from wild nests. Over half (51.4%) of the farmers reported loss of alligator nests in 2011; some 590 nests were damaged or destroyed on 36 separate properties across the state. Four farmers, some of whom have twenty or more years of experience collecting alligator eggs, reported this is the first year in which they have lost nests to feral swine. Other farmers reported seeing wild hogs while in the field or seeing sign of hogs, which suggests future potential losses may be incurred and that the range and population level of this non-native species is expanding in important alligator nesting habitat in Louisiana. Nearly all farmers who had nests destroyed by feral swine (94.7%) reported hog damage is increasing on their properties. Some farmers reported that hog removal efforts limited their feral swine damage this year relative to past years. In addition to deleterious effects on wetlands habitats caused by feral swine, the financial impact of loss of alligator egg revenue is significant.

Parachú Marcó, M.V., Piña, C.I. and Larriera, A. (2012). Presence of Red Fire Ants (*Solenopsis invicta* Buren) in Broad-snouted Caiman (*Caiman latirostris*) nests. Journal of Herpetology 46(2): 228-232.

Abstract: The presence of *Solenopsis invicta* in *Caiman latirostris* nests is suspected to be a possible cause of death in caiman hatchlings, but this has not been documented within the native distribution of this ant. In crocodilian ranching programs, wild eggs are collected from the field, and delays between collection and transportation to incubators are usually minimized in the hope of maximizing embryo survival. We analyzed nests harvested during 5 consecutive nesting seasons of *C. latirostris* to determine the phenology of *S. invicta* colonization of caiman nests. The percentages of colonized caiman nests for each season were calculated. Densities of *S. invicta* mounds built on bare ground were assessed to determine potential relationships between density and the proportion of caiman nests colonized by the end of nesting season. We also evaluated whether *S. invicta* preferred certain habitats to establish their mounds. We found no relationship between *S. invicta* mound densities and the percentage of *C. latirostris* nests with Red Fire Ants. The presence of *S. invicta* mounds among years was similar between different habitats at the beginning of each season. We found that *S. invicta* can colonize *C. latirostris* nests during the breeding period and that colonization of nests is higher than 50% in seasons where rainfall was 200 mm at the beginning of the season (December and January). In contrast, during years in which rainfall was below 200 mm, caiman nest colonization was reduced.

Platt, S.G., Thorbjarnarson, J.B. and Rainwater, T.R. (2012). Scalation of the American crocodile (Crocodylidae, Crocodilia) from the coastal zone of northern Belize. Caribbean Journal of Science 46: 332-338.

Abstract: We here describe scalation in a large sample (n= 80) of American crocodiles, *Crocodylus acutus*, collected from the coastal zone of northern Belize. Differences between our data and the few published descriptions of *C. acutus* were found among post-occipital, nuchal, dorsal, ventral, and double-crested caudal scale groups, suggesting that interpopulational differences in scalation may exist in this widely distributed species. Whether populations can be identified on the basis of scalation remains to be determined.

Nie, C., Li, Y., Zhao, J. and Wu, X. (2012). Extremely high major histocompatibility complex class IIb gene intron 2 variation and population structure in Chinese alligator. Journal of Genetics 91: e86-e91 (www.ias.ac.in/jgenet/OnlineResources/91/e86.pdf).

Brochu, C.A. and Storrs, G.W. (2012). A giant crocodile from the Plio-Pleistocene of Kenya, the phylogenetic relationships of Neogene African crocodylines, and the antiquity of *Crocodylus* in Africa. Journal of Vertebrate Paleontology 32(3): 587-602.

Abstract: We describe a new crocodile, *Crocodylus thorbjarnarsoni*, sp. nov., on the basis of skulls and jaws from Pliocene and Pleistocene deposits in the Lake Turkana Basin of Kenya. The new species has a comparatively broad, deep snout and resembles an extinct horned crocodile from the Quaternary of Olduvai Gorge (*C. anthropophagus*), but the squamosal 'horns' are not as well developed. The skull table has a strongly trapezoidal outline different from those of the living Nile crocodile (*C. niloticus*) and crocodiles from late Miocene deposits in the Turkana Basin. The largest specimens are from animals up to 7.5 m in total length. It would have been the largest predator in its environment, and the early humans found in the same deposits were presumably part of its prey base. A phylogenetic analysis, including the new species and an improved sample of extinct crocodyline diversity, suggests a more complex phylogenetic and biogeographic history for the clade in Africa and the eastern Indian Ocean region than previously supposed. The analysis limits the known geographic and stratigraphic range of *Rimasuchus lloydi*, previously thought to occur throughout Africa from the early Miocene through the Pleistocene of northern Africa. *Crocodylus niloticus* is not known with certainty from units older than the Quaternary, and most late

Miocene fossils from the Turkana Basin previously referred to *C. niloticus* can instead be referred to *C. checchiai*. The current first appearance datum for *Crocodylus* in Africa is approximately 7 Ma.

Arena, P.C., Steedman, C. and Warwick, C. (2012). Amphibian and Reptile Pet Markets in the EU: An Investigation and Assessment. Animal Protection Agency, Animal Public, Eurogroup for Animals, Eurogroup for Wildlife and Laboratory Animals, Fundación para la Adopción, el Apadrinamiento y la Defensa de los Animales, International Animal Rescue, and People for the Ethical Treatment of Animals.

Courtenay, G., Smith, D.R. and Gladstone, W. (2012). Occupational health issues in marine and freshwater research. Journal of Occupational Medicine and Toxicology (doi:10.1186/1745-6673-7-4).

Abstract: Marine and freshwater scientists are potentially exposed to a wide variety of occupational hazards. Depending on the focus of their research, risks may include animal attacks, physiological stresses, exposure to toxins and carcinogens, and dangerous environmental conditions. Many of these hazards have been investigated amongst the general population in their recreational use of the environment; however, very few studies have specifically related potential hazards to occupational exposure. For example, while the incidence of shark and crocodile attacks may invoke strong emotions and the occupational risk of working with these animals is certainly real, many more people are stung by jellyfish or bitten by snakes or dogs each year. Furthermore, a large proportion of SCUBA-related injuries and deaths are incurred by novice or uncertified divers, rather than professional divers using aquatic environments. Nonetheless, marine and freshwater research remains a potentially risky occupation, and the likelihood of death, injury and long-term health impacts still needs to be seriously considered.

McKittrick, J., Chen, P.-Y., Bodde, S.G., Yang, W., Novitskaya, E.E. and Meyers, M.A. (2012). The structure, functions, and mechanical properties of keratin. Journal of the Minerals, Metals and Materials Society (doi: 10.1007/s11837-012-0302-8).

Abstract: Keratin is one of the most important structural proteins in nature and is widely found in the integument in vertebrates. It is classified into two types: α-helices and β-pleated sheets. Keratinized materials can be considered as fiber-reinforced composites consisting of crystalline intermediate filaments embedded in an amorphous protein matrix. They have a wide variety of morphologies and properties depending on different functions. Here, we review selected keratin-based materials, such as skin, hair, wool, quill, horn, hoof, feather, and beak, focusing on the structure–mechanical property-function relationships and finally give some insights on bioinspired composite design based on keratinized materials.

Charruau, P. and Hénaut, Y. (2012). Nest attendance and hatchling care in wild American crocodiles (*Crocodylus acutus*) in Quintana Roo, Mexico. Animal Biology 62(2012): 29-51.

Abstract: Crocodilians show universal parental care, but few studies concentrate on this behavior in wild crocodiles. We studied nest and hatchling care in genetically pure wild American crocodiles (*Crocodylus acutus*) on two Caribbean islands of Mexico. From 2006 to 2009 we made direct observations of crocodile behavior upon discovery of nests and groups of hatchlings in Banco Chinchorro. In 2009, we installed camera traps at 4 nests from the time of their discovery to the hatching of each nest, in Banco Chinchorro and Cozumel Island. Twenty-one other species were observed to visit crocodile nests. No nest predation was observed but 9 species represented some danger to nests and/or hatchlings. Females seemed to remain in the nest vicinity during incubation. There was variability in nest visit frequencies and no nest defense toward human intrusion was observed. Visit frequency by other species at nests decreased with increased crocodile visitation. Crocodiles mainly visited nests on darker nights, corresponding to the visits of species representing greater danger for nests. Repair of the nest by females after disturbance was observed for the first time in wild American crocodiles. Crocodile visits were more frequent at the beginning and the end of incubation, which could represent different antipredation strategies. Although adult crocodiles helped during hatching for the emergence of neonates, hatchling care seemed reduced compared to other crocodile species. We provide the first data on nesting behavior of genetically pure American crocodiles in the Yucatan peninsula, which provides a base for future comparisons with Morelet's crocodiles and their hybrids.

Somaweera, R. and Shine, R. (2012). Nest-site selection by crocodiles at a rocky site in the Australian tropics: Making the best of a bad lot. Austral Ecology (doi: 10.1111/j.1442-9993.2012.02406.x).

Abstract: Most animals select nest sites non-randomly, reflecting benefits of specific locations or incubation conditions for offspring viability as well as risks or costs to the reproducing adult. If few or no available nest sites offer suitable conditions, we expect animals to make the best of a bad lot, by selecting nest sites that provide the best conditions available. In tropical north-western Australia, freshwater crocodiles (*Crocodylus johnstoni*: Crocodylidae) in a large artificial lake (Lake Argyle) experience this challenge: the types of nest sites used by this species in other parts of its range (moist, shaded sandy soils, far from the water's edge) are scarce. Measurements of 89 crocodile nests and 89 test holes (abandoned attempts at nesting) at Lake Argyle, and 28 nests on the nearby Ord River, show that most areas along the lakeshore are too steep and rocky for nesting. Crocodiles at the lake therefore are forced to nest at sites that are sun-exposed, in dry gravelly substrates, and close to the water's edge. Comparisons of test holes and actual nests within such areas show that nesting crocodiles actively select sites

that are less rocky, are suitable hydrically, and that provide stable thermal regimes. Those hydric and thermal attributes allow successful development of the offspring. The ability of freshwater crocodiles in Lake Argyle to flexibly modify their nest-site selection criteria, under severe constraints enforced by this open rocky landscape, are critical to the species' success in exploiting the opportunity created by the dam's construction.

Rafferty, A.R. and Reina, R. (2012). Arrested embryonic development: a review of strategies to delay hatching in egg-laying reptiles. Proceedings of the Royal Society B. (doi: 10.1098/rspb.2012.0100).

Abstract: Arrested embryonic development involves the downregulation or cessation of active cell division and metabolic activity, and the capability of an animal to arrest embryonic development results in temporal plasticity of the duration of embryonic period. Arrested embryonic development is an important reproductive strategy for egg-laying animals that provide no parental care after oviposition. In this review, we discuss each type of embryonic developmental arrest used by oviparous reptiles. Environmental pressures that might have directed the evolution of arrest are addressed and we present previously undiscussed environmentally dependent physiological processes that may occur in the egg to bring about arrest. Areas for future research are proposed to clarify how ecology affects the phenotype of developing embryos. We hypothesize that oviparous reptilian mothers are capable of providing their embryos with a level of phenotypic adaptation to local environmental conditions by incorporating maternal factors into the internal environment of the egg that result in different levels of developmental sensitivity to environmental conditions after they are laid.

Olsson, A. and Phalen, D. (2012). Preliminary studies of chemical immobilization of captive juvenile estuarine (*Crocodylus porosus*) and Australian freshwater (*C. johnstoni*) crocodiles with medetomidine and reversal with atipamezole. Veterinary Anaesthesia and Analgesia (doi: 10.1111/j.1467-2995.2012.00721.x).

Abstract: Objective: To establish a safe, reliable and reversible immobilization protocol for captive juvenile crocodiles. Study design: Prospective, randomized, clinical study. Animals: Thirty male estuarine crocodiles (body mass 1-12.1 kg) and 10 male Australian freshwater crocodiles (body mass 4.1-12.8 kg). Methods: An optimized dose of medetomidine (0.5 mg kg^{-1}) was administered intramuscularly (IM) into the tail (Group 1; n= 5), pelvic limb (Group 2; n= 5) and thoracic limb (Groups 3 and 4; n= 5 in each group) of estuarine crocodiles weighing 3-12.1 kg. Their heart and respiratory rates and degree of immobilization were monitored every 15 minutes until recovery and daily thereafter for 3 subsequent days. In Group 4 (n= 5), medetomidine was antagonized with an optimized dose of atipamezole (2.5 $mg.kg^{-1}$) given IM into the thoracic limb and time to recovery recorded. The effects of increasing doses of medetomidine given IM in the thoracic limb (n= 4) and intravenously (n= 6) were determined in 1-2 kg estuarine crocodiles. Australian freshwater crocodiles (4.1-12.8 kg) were administered medetomidine IM into the thoracic limb in divided doses at 0.5 $mg.kg^{-1}$ (n= 5) and 0.75 $mg.kg^{-1}$ (n= 5) and similarly monitored. Results: Immobilization was achieved only in the estuarine crocodiles >3 kg and when medetomidine was administered into the thoracic limb. Immobilization was achieved within 30 minutes and the duration of immobilization lasted approximately 90 minutes. Immobilization in estuarine crocodiles was readily reversed with atipamezole. A dose of 0.75 $mg.kg^{-1}$ was required to immobilize Australian freshwater crocodiles and the onset of immobilization was longer and the duration shorter than seen in the estuarine crocodiles. The heart and respiratory rates of all immobilized animals decreased significantly and arterial blood pressure became undetectable in the animals in which it was measured. Conclusions and clinical relevance: Medetomidine administered in the thoracic limb of captive estuarine and Australian freshwater crocodiles, ranging from 3 to 12.8 kg, provides a predictable onset and duration of immobilization sufficient for physical examination, sample collection, short minor procedures and translocation of the animals. Atipamezole administered in the thoracic limb results in complete reversal of the effects of medetomidine in the estuarine crocodile and a rapid return to normal behaviour.

Forrester, J.A., Holstege, C.P. and Forrester, J.D. (2012). Fatalities from venomous and nonvenomous animals in the United States (1999-2007). Wilderness & Environmental Medicine 23(2): 146-152.

Abstract: Objective: To review recent (1999-2007) US mortality data from deaths caused by nonvenomous and venomous animals and compare recent data with historic data. Methods: The CDC WONDER Database was queried to return all animal-related fatalities between 1999 and 2007. Rates for animal-related fatalities were calculated using the estimated 2003 US population. Inclusion criteria included all mortalities that were a consequence of bite, contact, attack, or envenomation (ICD-10 codes W53–W59 and X20-X29). Results: There were 1802 animal-related fatalities with the majority coming from nonvenomous animals (60.4%). The largest percentage (36.4%) of animal-related fatalities was attributable to "other mammals," which is largely composed of farm animals. Deaths attributable to Hymenoptera (hornets, wasps, and bees) have increased during the past 60 years in the United States and now account for more than 79 fatalities per year and 28.2% of the total animal-related fatalities from 1999 to 2007. Dog-related fatalities have increased in the United States, accounting for approximately 28 fatalities per year and 13.9% of the total animal-related fatalities. Conclusions: Prevention measures aimed at minimizing injury from animals should be directed at certain high-risk groups such as farmworkers, agricultural workers, and parents of children with dogs.

Warwick, C. and Steedman, C. (2012). Injuries, envenomations and stings from exotic pets. J. Roy. Soc. Med. 105(7): 296-299.

Abstract: A variety of exotic vertebrate and invertebrate species are kept as 'pets' including fishes, amphibians (for example, frogs and toads), reptiles (turtles, crocodiles, lizards and snakes), birds, mammals (for example, primates, civets, and lions), and invertebrates (for example spiders, scorpions, and centipedes), and ownership of some of these animals is rising. Data for 2009-2011 suggest that the number of homes with reptiles rose by approximately 12.5%. Recent surveys, including only some of these animals, indicated that they might be present in around 18.6% of homes (equal to approximately 42 million animals of which around 40 million are indoor or outdoor fish). Many exotic 'pets' are capable of causing injury or poisoning to their keepers and some contacts prove fatal. We examined NHS Health Episode Statistics for England using selected formal categories for hospital admissions and bed days for 2004-2010 using the following categories of injury, envenomation or sting; bitten or struck by crocodile or alligator; bitten or crushed by other reptiles: contact with venomous snakes and lizards; contact with scorpions. Between 2004 and 2010 these data conservatively show a total of 760 full consultation episodes, 709 admissions and 2121 hospital bed days were associated with injuries probably from exotic pets. Injuries, envenomations and stings from exotic pets constitute a small but important component of emerging medical problems. Greater awareness of relevant injuries and medical sequelae from exotic pet keeping may help medics formulate their clinical assessment and advice to patients.

Gienger, C.M., Tracy, C.R., Brien, M.L., Manolis, S.C., Webb, G.J.W., Seymour, R.S. and Christian, K.A. (2012). Energetic costs of digestion in Australian crocodiles. Aust. J. Zool. (dx.doi.org/10.1071/ZO12018).

Abstract: We measured standard metabolic rate (SMR) and the metabolic response to feeding in the Australian crocodiles, *Crocodylus porosus* and *C. johnsoni*. Both species exhibit a response that is characterised by rapidly increasing metabolism that peaks within 24 h of feeding, a postfeeding metabolic peak (peak V O_2) of 1.4-2.0 times SMR, and a return to baseline metabolism within 3-4 days after feeding. Postfeeding metabolism does not significantly differ between species, and crocodiles fed intact meals have higher total digestive costs (specific dynamic action; SDA) than those fed homogenised meals. Across a more than 100-fold range of body size (0.190 to 25.96 kg body mass), SMR, peak V O_2, and SDA all scale with body mass to an exponent of 0.85. Hatchling (≤1 year old) *C. porosus* have unexpectedly high rates of resting metabolism, and this likely reflects the substantial energetic demands that accompany the rapid growth of young crocodilians.

Hsi-yin, S., Yen-nien, C. and Xiao-chun, W. (2012). The first fossil skull of *Alligator sinensis* from the Pleistocene, Taiwan, with a paleogeographic implication of the species. J. Asian Earth Studies (dx.doi.org/10.1016/j.jseaes.2012.05.026).

Abstract: A nearly complete fossil skull of Alligatoridae from the Pleistocene, Penghu Channel, east of Taiwan, is reported. It can be referred to the most latest clade of Alligatorinae, which includes *Alligator sinensis*, *Alligator mississippiensis* and *Alligator mefferdi*, on the basis of the following features: the splenial is excluded from the mandibular symphysis; the anterior tip of the splenial passes dorsal to the Meckelian groove; and the mandible is gently curved between the fourth alveoli and the mid dentary. It differs from *A. mississippiensis* and *A. mefferdi* mainly in the following characters: the breadth between the supratemporal fenestrae is approximately equal to the interorbital width, the snout is about half the length of the skull; and the anterior part of the snout is subtriangular in dorsal view. These features suggest that the Penghu alligator is most probably referable to *A. sinensis*. This is the only fossil skull of *A. sinensis* known. The discovery of the skull in Penghu Channel not only provides the first solid fossil evidence to indicate that the geological distribution of *A. sinensis* extended farther southeast than the historical/archaeological range of the species but also adds new information on the biodiversity of the Penghu fauna.

Srihongthong, S., Pakdeesuwan, A., Daduang, S., Araki, T., Dhiravisit, A. and Thammasirirak, S. (2012). Complete amino acid sequence of globin chains and biological activity of fragmented crocodile hemoglobin (*Crocodylus siamensis*). Protein J. 31(6): 466-476.

Abstract: Hemoglobin, α-chain, β-chain and fragmented hemoglobin of *Crocodylus siamensis* demonstrated both antibacterial and antioxidant activities. Antibacterial and antioxidant properties of the hemoglobin did not depend on the heme structure but could result from the compositions of amino acid residues and structures present in their primary structure. Furthermore, 13 purified active peptides were obtained by RP-HPLC analyses, corresponding to fragments in the α-globin chain and the β-globin chain which are mostly located at the N-terminal and C-terminal parts. These active peptides operate on the bacterial cell membrane. The globin chains of *Crocodylus siamensis* showed similar amino acids to the sequences of *Crocodylus niloticus*. The novel amino acid substitutions of α-chain and β-chain are not associated with the heme binding site or the bicarbonate ion binding site, but could be important through their interactions with membranes of bacteria.

Sladky, K.K. (2012). Clinical analgesia in reptiles. Journal of Exotic Pet Medicine 21(2): 158-167.

Abstract: Reptile pain and analgesia is only beginning to be understood in veterinary research and clinical medicine. The diversity of the class Reptilia also makes it difficult to extrapolate analgesic efficacy across species. Many veterinary clinicians argue that the administration of analgesic medication is risky to the patient and may mask behavioral signs of pain, which are considered evolutionarily adaptive for survival. However, veterinarians have an ethical obligation to treat painful conditions in all animals, including reptiles, because effective pain management reduces stress-induced disruption

to homeostatic mechanisms and also decreases morbidity and mortality associated with trauma or surgery. Nevertheless, several obstacles limit successful analgesic use, including subjectivity of pain assessment, inadequate knowledge regarding analgesic efficacy across species, pharmacokinetics of analgesic drugs, and the unknown relationship between risks and benefits for this class of drugs. The objective of this review is to provide a current perspective on the practical application of analgesic medication in commonly maintained pet reptile species.

Sultana, S., Chowdhury, .H., Parvin, R., Saha, S.S., Rahman, S.M., Haider, M.G., Arif, A.S.M., Rahman, S. and Song, H.J. (2012). *Escherichia coli* septicemia concurrent with mycotic infection in captive saltwater crocodiles in Bangladesh. Korean Journal of Veterinary Service 35(1): 47-51.

Abstract: Crocodile farms are getting popular in Bangladesh in an economic point of view. In one of the farms, some crocodiles were found sick and three of them died between May and July in 2006. This investigation was performed to diagnose the cause of the death. Routine postmortem examination was conducted. Samples were collected in 10% neutral buffered formalin for histopathology and in falcon tube for microbiological study. Additional swabs were collected in nutrient broth. Histopathological and microbiological studies were conducted using routine procedures. In addition Giemsa, Gram and PAS stains were performed to detect the organism in tissues. Grossly, esophagus, trachea, lungs, liver, spleen, heart and kidney were congested. Intestine, rectum and colon were hemorrhagic. Clay colored material was found in colo-rectum. Purulent exudates in lungs and thick and cloudy pericardial fluid in pericardial sac were found. Histologically, multifocal granulomatous inflammation was evident in lung, liver, kidney, intestine and colon with bacterial colonies, fungal spores and hyphae. These bacteria were appeared as Gram negative. Fungal hyphae and spores were detected in liver, lungs and colon by using PAS stain. Bacteriologically, *E. coli* were isolated from lungs exudates, pericardial fluids and intestinal fluids. Therefore, it can be concluded that 3 crocodiles died due to *E. coli* septicemia concurrent with mycotic infection.

Olsson, A. and Phalen, D. (2012). Medetomidine immobilisation and atipamezole reversal in large estuarine crocodiles (*Crocodylus porosus*) using metabolically scaled dosages. Australian Veterinary Journal (doi: 10.1111/j.1751-0813.2012.00907.x).

Abstract: Restraint of large estuarine crocodiles is potentially dangerous. Neuromuscular blockers and other immobilising drugs have been used with variable results. Medetomidine has been reported as a reliable, repeatable and reversible immobilisation agent in small estuarine crocodilians. Two wild and two farmed male animals, between 3.05 and 4.6 m long, were hand-injected into a triceps muscle with a metabolically scaled medetomidine dosage. Immobilisation occurred within 30 min. At the conclusion of the procedures, 70 min after medetomidine administration, three animals were injected with atipamezole IM into the opposite triceps muscle at a dosage based on body surface area. Reversal occurred within 5 min. The fourth animal was intubated prior to reversal of medetomidine and maintained on isoflurane anaesthesia for a gastrotomy. All animals were monitored closely post recovery and then regularly for at least 1 week. Medetomidine at a metabolically scaled dosage delivered IM into the forelimb was effective for immobilising large estuarine crocodiles for at least 40 min. Atipamezole administered at a dosage calculated as a function of surface area effectively reversed this immobilisation.

Radloff, F.G.T., Hobson, K.A. and Leslie, A.J. (2012). Characterising ontogenetic niche shifts in Nile crocodile using stable isotope (δ13C, δ15N) analyses of scute keratin. Isotopes in Environmental and Health Studies (http://dx.doi.org/10.1080/10256016.2012.667808).

Abstract: Nile crocodiles undergo a three to five order of magnitude increase in body size during their lifespan. This shift coincides with a change in resource and habitat use which influences the strength, type and symmetry of interactions with other species. Identifying size-specific crocodile groups displaying similar traits is important for conservation planning. Here, we illustrate how stable carbon (δ13C) and nitrogen (δ15N) isotope analysis of scute keratin, together with breakpoint modelling analysis can be used to characterise ontogenetic niche shifts. Using a sample set of 238 crocodiles from the Okavango Delta, Botswana (35-463 cm total length), we found prominent size-related changes in the scute keratin δ13C and δ15N profiles close to 40 and 119 cm snout-vent length. The first shift corroborated the findings of a traditional stomach-content study conducted on the same population at the same time, and the second conformed to known crocodile ecology. This approach can be used as a first approximation to identify size-specific groups within crocodile populations, and these can then be investigated further using isotopic or other methods.

Barboza, N.N., Mussart, N.B., Koza, G.A. and Coppo, J.A. (2012). Internal environment in juvenile specimens of *Caiman latirostris* and *Caiman yacare* from Argentina. Physiological variations according to species, sex, liveweight, size, and season of the year. REDVET 13(3). (http://www.veterinaria.org/revistas/redvet/n030312.html).

Abstract: Internal environment fluids, mainly the blood, are the reflex of the metabolic-nutritional state of the organism. In order to optimize the captive breeding of caymans it is necessary to find appropriate diets to accelerate their growth. Diets can be evaluated through weight gains, body size and blood nutritional indicators. The objective of this assay was to obtain reference values and physiological variations of this parameters, in juvenile *Caiman latirostris* and *Caiman yacare*. In a hatchery in northeastern Argentina, 207 caymans (50% of each species and sex), which were fed *ad libitum* with meat flour and balanced pellets (47 and 37% protein

respectively), were studied. Weighings and measurements of five body dimensions and 39 blood analytes, were carried out in each season during one year. Results were processed by means of multivariate analysis of the variance (MANOVA) and they showed significant differences between species and between seasons ($p<0.05$), but not between sexes. On average, albumin, glucose, calcium, magnesium, potassium, hemoglobin, MCH, MCHC, MCV, GGT, total length, muzzle-tail length, head width, thoracic perimeter and liveweight, were higher in *C. latirostris*. In contrast, total protein, globulin, uric acid, total cholesterol, triglycerides, LDL-C, sodium, copper, hematocrit, erythrocytes, leukocytes, CPK, ALP, AST, CHE, LDH and head length, were higher in *C. yacare*. Nutritional indicators revealed higher values in summer, circumstance attributed to the cessation of feeding during the caymans winter lethargy. The absence of intersexual variations should be interpreted keeping in mind that the animals were young specimens that still didn't manifest reproductive behavior. In conclusion, here are reported reference values for captive sub-adult *C. latirostris* and *C. yacare*. Liveweight, morphometric sizes, and biochemical values varied according to species and season of the year. It is expected that this knowledge can be applied to improve the cayman breeding system.

Yang, W., Chen, I.H., McKittrick, J. and Meyers, M.A. (2012). Flexible dermal armor in nature. Journal of the Minerals, Metals and Materials Society (doi: 10.1007/s11837-012-0301-9).

Abstract: Many animals possess dermal armor, which acts primarily as protection against predators. We illustrate this through examples from both our research and the literature: alligator, fish (alligator gar, arapaima, and Senegal bichir), armadillo, leatherback turtle, and a lizard, the Gila monster. The dermal armor in these animals is flexible and has a hierarchical structure with collagen fibers joining mineralized units (scales, tiles, or plates). This combination significantly increases the strength and flexibility in comparison with a simple monolithic mineral composite or rigid dermal armor. This dermal armor is being studied for future bioinspired armor applications providing increased mobility.

Cubo, J., Le Roy, N., Martinez-Maza, C. and Montes, L. (2012). Paleohistological estimation of bone growth rate in extinct archosaurs. Paleobiology 38(2): 335-349.

Abstract: The clade Archosauria contains two very different sister groups in terms of diversity (number of species) and disparity (phenotypic variation): Crurotarsi (taxa more closely related to crocodiles than to birds) and Ornithodira (pterosaurs and dinosaurs including birds). The extant species of Crurotarsi may constitute a biased sample of past biodiversity regarding growth patterns and metabolic rates. Bone histological characters can be conserved over hundreds of millions of years in the fossil record and potentially contain information about individual age at death, age at sexual maturity, bone growth rates, and basal metabolic rates of extinct vertebrates. Using a sample of extant amniotes, we have constructed a paleobiological model to estimate bone growth rate from bone histological traits. Cross-validation tests show that this model is reliable. We then used it to estimate bone growth rates in a sample of extinct archosaurs including Crurotarsi and Ornithodira. After testing for phylogenetic signal, optimization of femoral growth rates through squared change parsimony onto a time-calibrated tree of amniotes shows two divergent evolutionary trends: whereas bone growth rates increase from the last common ancestor of Ornithodira to extant birds, they decrease from the last common ancestor of Crurotarsi to extant crocodiles. However, we conclude, on the basis of recent evidence for unidirectional airflow in the lungs of alligators, that crocodiles may have retained the capacity of growing at high rates.

Wu, Q., Wu, X. and Glenn, T. (2012). Fourteen novel microsatellite loci in the Chinese alligator (*Alligator sinensis*) isolated via 454 pyrosequencing. Conservation Genetics Resources (doi: 10.1007/s12686-012-9632-7).

Abstract: The Chinese alligator (*Alligator sinensis*) is one of the most endangered crocodilians in the world. In this study, 14 novel microsatellite loci were developed for this rare species via 454 high-throughput sequencing. These polymorphic microsatellites yielded an average of 2.93 alleles per locus among 40 individuals scored. The observed and expected heterozygosities (HO and HE) ranged from 0.025 to 0.975 and from 0.025 to 0.651, with averages of 0.439 and 0.426, respectively. These microsatellite markers will be useful for individual identification, mate choice for captive breeding and other relevant genetic investigations of Chinese alligator.

Tate, K.B., Eme, J., Swart, J., Conlon, J.M. and Crossley II, D.A. (2012). Effects of dehydration on cardiovascular development in the embryonic American alligator (*Alligator mississipiensis*). Comp. Biochem. Physiol. A Mol. Integr. Physiol. 162(3): 252-258.

Abstract: Effects of dehydration on reptilian embryonic cardiovascular function are unknown. Here, we present the first morphological and physiological data quantifying the cumulative effects of four acute dehydration events on the embryonic American alligator, *Alligator mississipiensis*. We hypothesized that dehydration would alter embryonic morphology, reduce blood volume and augment the response to angiotensin II (Ang II), a key osmotic and blood volume regulatory response element in adult vertebrates. Drying events at 30%, 40%, 50%, and 60% of embryonic incubation reduced total egg water content by 14.43 ± 0.37 g. Embryonic blood volume was greater in the dehydration group at 70% of embryonic incubation compared to controls (0.39 ± 0.044 mL g^{-1} and 0.22 ± 0.03 mL g^{-1}, respectively), however, both groups were similar at 90% of incubation (0.18 ± 0.02 mL g^{-1} control and 0.23 ± 0.03 mL g^{-1} dehydrated). Dehydration altered the morphological phenotype and resulted in an overall reduction in embryonic mass at both incubation time points measured. Dehydration also altered the physiological phenotype, resulting in embryonic alligators that were

relatively bradycardic at 90% of incubation. Arterial Ang II injections resulted in a dose dependent hypertension, which increased in intensity over the span of incubation studied. While progressive incubation altered the Ang II response, dehydration had no impact on the cardiovascular responses to the peptide. Quantification of Ang II type-1 receptor protein using Western Blot analysis illustrated that dehydration condition and incubation time point did not alter protein quantity. Collectively, our results show that dehydration during embryonic development of the American alligator alters embryonic morphology and baseline heart rate without altering arterial pressure and response to Ang II

Erickson, G.M., Gignac, P.M., Steppan, S.J., Lappin, A.K., Vliet, K.A., Breuggen, J.D., Inouye, B.D., Kledzik, D. and Webb, G.J.W. (2012). Insights into the ecology and evolutionary success of crocodilians revealed through bite-force and tooth-pressure Experimentation. PLoS ONE 7(3): e31781. doi:10.1371/journal.pone.0031781.

Abstract: Crocodilians have dominated predatory niches at the water-land interface for over 85 million years. Like their ancestors, living species show substantial variation in their jaw proportions, dental form and body size. These differences are often assumed to reflect anatomical specialization related to feeding and niche occupation, but quantified data are scant. How these factors relate to biomechanical performance during feeding and their relevance to crocodilian evolutionary success are not known. **W**e measured adult bite forces and tooth pressures in all 23 extant crocodilian species and analyzed the results in ecological and phylogenetic contexts. We demonstrate that these reptiles generate the highest bite forces and tooth pressures known for any living animals. Bite forces strongly correlate with body size, and size changes are a major mechanism of feeding evolution in this group. Jaw shape demonstrates surprisingly little correlation to bite force and pressures. Bite forces can now be predicted in fossil crocodilians using the regression equations generated in this research. Critical to crocodilian long-term success was the evolution of a high bite-force generating musculo-skeletal architecture. Once achieved, the relative force capacities of this system went essentially unmodified throughout subsequent diversification. Rampant changes in body size and concurrent changes in bite force served as a mechanism to allow access to differing prey types and sizes. Further access to the diversity of near-shore prey was gained primarily through changes in tooth pressure via the evolution of dental form and distributions of the teeth within the jaws. Rostral proportions changed substantially throughout crocodilian evolution, but not in correspondence with bite forces. The biomechanical and ecological ramifications of such changes need further examination.

Butler, R.J., Barrett, P.M. and Gower, D.J. (2012). Reassessment of the evidence for postcranial skeletal pneumaticity in Triassic archosaurs, and the early evolution of the avian respiratory system. PLoS ONE 7(3): e34094. doi:10.1371/journal.pone.0034094.

Abstract: Uniquely among extant vertebrates, birds possess complex respiratory systems characterised by the combination of small, rigid lungs, extensive pulmonary air sacs that possess diverticula that invade (pneumatise) the postcranial skeleton, unidirectional ventilation of the lungs, and efficient crosscurrent gas exchange. Crocodilians, the only other living archosaurs, also possess unidirectional lung ventilation, but lack true air sacs and postcranial skeletal pneumaticity (PSP). PSP can be used to infer the presence of avian-like pulmonary air sacs in several extinct archosaur clades (non-avian theropod dinosaurs, sauropod dinosaurs and pterosaurs). However, the evolution of respiratory systems in other archosaurs, especially in the lineage leading to crocodilians, is poorly documented. Here, we use μCT-scanning to investigate the vertebral anatomy of Triassic archosaur taxa, from both the avian and crocodilian lineages as well as non-archosaurian diapsid outgroups. Our results confirm previous suggestions that unambiguous evidence of PSP (presence of internal pneumatic cavities linked to the exterior by foramina) is found only in bird-line (ornithodiran) archosaurs. We propose that pulmonary air sacs were present in the common ancestor of Ornithodira and may have been subsequently lost or reduced in some members of the clade (notably in ornithischian dinosaurs). The development of these avian-like respiratory features might have been linked to inferred increases in activity levels among ornithodirans. By contrast, no crocodile-line archosaur (pseudosuchian) exhibits evidence for unambiguous PSP, but many of these taxa possess the complex array of vertebral laminae and fossae that always accompany the presence of air sacs in ornithodirans. These laminae and fossae are likely homologous with those in ornithodirans, which suggests the need for further investigation of the hypothesis that a reduced, or non-invasive, system of pulmonary air sacs may be have been present in these taxa (and secondarily lost in extant crocodilians) and was potentially primitive for Archosauria as a whole.

Liu, Z., Brandt, L.A., Ogurcak, D.E. and Mazzotti, F.J. (2012). Morphometric and hydrologic characteristics of alligator holes in Everglades National Park, Florida from 1994 to 2007. Ecohydrology (doi: 10.1002/eco.1266).

Abstract: Alligator (*Alligator mississippiensis*) holes are a key feature in the Everglades landscape providing aquatic refuge for alligators and other aquatic organisms. The morphology of the hole as well as its location in the landscape may influence its function as an aquatic refugium. Morphologic and hydrologic characteristics and dynamics of 50 alligator holes in Everglades National Park, Florida were examined based on 1-m resolution digital images and field measurements from 1994 to 2007. Major morphometric parameters of alligator holes calculated for the study area included surface area, diameter, major axis orientation, basin depth, and circularity index. We used basin depth along with surface water modelling from the Everglades Depth Estimation Network to describe alligator hole hydroperiod and examine relationships among morphologic features, habitat, and hydrology. Alligator holes in this study were similar morphologically (pond surface area, basin depth, and sediment depth) among locations and habitats, and for the most part over time with

the exception of holes in the Rocky glades. Alligator holes with greater surface area were not necessarily deeper holes. Hole hydroperiod was not correlated with surface area, and larger holes did not dry out less frequently than smaller holes. Although marsh hydroperiods varied by location and habitat, alligator hole hydroperiod did not, illustrating that across the landscape alligator holes provide aquatic refugia under a range of hydrologic conditions.

Wheatley, P.V., Peckham, H., Newsome, S.D. and Koch, P.L. (2012). Estimating marine resource use by the American crocodile *Crocodylus acutus* in southern Florida, USA. Mar. Ecol. Prog. Ser. 447: 211-222.

Abstract: Alligators and crocodiles differ in their physiological capacity to live in saline waters. Crocodiles can tolerate high-salinity water, at least for limited timeframes, whereas alligators and their close relatives cannot. Experiments have placed different crocodylians in various water salinities to document physiological responses, but no study has estimated the extent to which natural populations of crocodylids can live independent of fresh water. Here we estimated marine food and perhaps seawater contributions to a population of American crocodile *Crocodylus acutus* in southernmost Florida, USA. We evaluated the use of carbon, oxygen, and strontium isotopes as tracers of marine versus terrestrial sources. We compared *C. acutus* isotopic values to those of marine reptiles (marine iguanas and Pacific loggerhead turtles) and to American alligators, which require fresh water. We found that freshwater reptiles can be discriminated from those that drink seawater (or survive on metabolic and prey-included water in saline habitats) based on the magnitude of population-level oxygen isotope variation in bioapatite, whereas mean carbon isotope values discriminate between marine versus terrestrial food consumption. We used a 2 end-member (seawater and fresh water) mixing model to calculate percentage of marine resources used by *C. acutus*. Results indicate that adult *C. acutus* in southern Florida use marine food about 65% of the time and seawater or water gleaned from marine food about 80% of the time. This suggests that behavioral osmoregulatory techniques (ie seeking fresh water specifically for drinking, as suggested by other researchers) may not be necessary and that *C. acutus* is capable of being largely ecologically independent of fresh water.

La Grange, Govender, D. and Mukaratirwa, S. (2012). The occurrence of *Trichinella zimbabwensis* in naturally infected wild crocodiles (*Crocodylus niloticus*) from the Kruger National Park, South Africa. Journal of Helminthology (doi:10.1017/S0022149X12000089).

Abstract: *Trichinella zimbabwensis* has been found naturally infecting crocodiles (*Crocodylus niloticus*) in Zimbabwe, Mozambique, Ethiopia and South Africa, as well as monitor lizards (*Varanus niloticus*) in Zimbabwe. The reports on natural infections were mostly accidental rather than structured surveys and involved very few animals. Previous surveillance studies in South Africa reported a 38.5% prevalence of *T. zimbabwensis* among wild crocodiles tested from the Mpumalanga province and Kruger National Park (KNP). No studies have been conducted to date on the geographical distribution and occurrence of *T. zimbabwensis* in wild crocodiles and varans in countries in southern Africa. Recent outbreaks of pansteatitis in crocodile populations of the KNP, South Africa, provided an opportunity to conduct a more structured survey aimed at elucidating the occurrence and distribution of *T. zimbabwensis* in culled wild crocodile populations within the KNP. Results from this study showed that *T. zimbabwensis* occurred in 10 out of 12 culled crocodiles form the KNP. The results also showed that the natural distribution of *T. zimbabwensis* in crocodiles includes all the major river systems in the KNP. The predilection sites of larvae in muscles followed a different pattern in naturally infected crocodiles compared to observations in experimentally infected mammalian hosts.

Buthelezi, S., Southway, C., Govinden, U., Bodenstein, J. and Du Toit, K. (2012). An investigation of the antimicrobial and anti-inflammatory activities of crocodile oil. Journal of Ethnopharmacology (dx.doi.org/10.1016/j.jep.2012.06.040).

Abstract: Crocodile oil has been used by traditional practitioners world-wide to treat microbial infections and inflammatory conditions. However, the scientific rationale behind its use is not completely understood. This study provides an updated fatty acid profile and novel scientific evidence of the antimicrobial and anti-inflammatory properties of crocodile oil, obtained from the Nile crocodile (*Crocodylus niloticus*), justifying its use by traditional healers. The fatty acid content of the oil was determined by gas chromatography and the major fatty acids were identified. A microplate method was used to assess activity of the oil against *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Candida albicans*. The anti-inflammatory activity of the oil was assessed by oral administration and topical application, utilising a mouse model of acute croton oil-induced contact dermatitis. Sixteen fatty acids were identified with oleic, palmitic and linoleic acid being the major components of the oil. The optimal activity of the oil against the bacteria and fungus was obtained with 15% and 6% (w/v) oil respectively. No significant selectivity was observed against the bacterial species, but *Candida albicans* was more susceptible. The anti-inflammatory assays showed optimal activity at 3 h after the oral administration of oil (60.8 ± 5.5%) and at 12 h after topical application (57.5 ± 5.9%). This suggested a short duration of action when the oil was orally administered, and a longer duration of action when it was topically applied. Subsequent studies may be directed towards the investigation of the mechanisms of action of the antimicrobial and anti-inflammatory activities of crocodile oil and its fatty acids.

Claessens, L.P.A.M. and Vickaryous, M.K. (2012). The evolution, development and skeletal identity of the crocodylian pelvis: Revisiting a forgotten scientific debate. J. Morphol. (doi: 10.1002/jmor.20059).

Abstract: Unlike most tetrapods, in extant crocodylians the acetabulum is formed by only two of the three skeletal

elements that constitute the pelvis, the ilium, and ischium. This peculiar arrangement is further confused by various observations that suggest the crocodylian pelvis initially develops from four skeletal elements: the ilium, ischium, pubis, and a novel element, the prepubis. According to one popular historical hypothesis, in crocodylians (and many extinct archosaurs), the pubis fuses with the ischium during skeletogenesis, leaving the prepubis as a distinct element, albeit one which is excluded from the acetabulum. Whereas the notion of a distinct prepubic element was once a topic of considerable interest, it has never been properly resolved. Here, we combine data gleaned from a developmental series of *Alligator mississippiensis* embryos, with a revised interpretation of fossil evidence from numerous outgroups to Crocodylia. We demonstrate that the modern crocodylian pelvis is composed of only three elements: the ilium, ischium, and pubis. The reported fourth pelvic element is an unossified portion of the ischium. Interpretations of pelvic skeletal homology have featured prominently in sauropsid systematics, and the unambiguous identification of the crocodylian pubis provides an important contribution to address larger scale evolutionary questions associated with locomotion and respiration.

Saalfeld, D.T., Conway, W.C. and Calkins, G.E. (2012). Nest success and hatchling survival of American alligators within inland wetlands of east Texas. The Journal of Wildlife Management (doi: 10.1002/jwmg.413).

Abstract: Because of liberalization of American alligator (*Alligator mississippiensis*) harvest management in Texas, estimates of nest success and hatchling survival for inland populations are essential for long-term, sustainable population and harvest management. To date, few studies have examined American alligator nest success and hatchling survival. We initiated a 3-year study from 2006 to 2008 to document alligator nest success and hatchling survival within several wetlands in east Texas. From June 2006 to August 2008, we located 30 nests from 3 wetlands within east Texas, where overall nest success was 44.2% (95% CI= 25.1-63.1%), irrespective of year. Nest circumference and day during the nesting season exerted the greatest influence on nest success. Additionally, from August 2006 to August 2008 we captured, marked, and released 271 hatchling alligators at Little Sandy National Wildlife Refuge, and recaptured an additional 192 hatchling alligators during this time. We estimated yearly apparent survival at 6.0% (95% CI= 2.0-14.6%) for hatchling alligators born in 2006 and 43.0% (95% CI= 28.4-57.8%) for those hatched in 2007. Variation in nest success and hatchling survival was likely attributed to fluctuating water levels and habitat management practices. Alligator harvest regulations need to account for variability in nest success and hatchling survival by including site-specific estimates of these metrics into harvest models. Failing to account for spatial and temporal variation in nest success and hatchling survival may result in unsustainable harvest and/or overharvest.

Barrios-Quiroz, G., Casas-Andreu, G. and Escobedo-Galván, A.H. (2012). Sexual size dimorphism and allometric growth of Morelet's crocodiles in captivity. Zoological Science 29(3): 198-203.

Abstract: Few studies have conducted morphological analyses of crocodilians, and little information exists on differences between size-classes and sexes in Neotropical crocodilians. In this study, we measured 9 morphological traits in 121 captive Morelet's crocodiles *Crocodylus moreletii* (81 females and 40 males). Our results revealed that individuals <2 m total length do not exhibit sexual dimorphism in morphometric characteristics. However, for crocodiles over 2 m in length, males were significantly larger than females in terms of dorsal-cranial length, cranial width, snout width and snout-ventral length. In general, morphological traits demonstrated a strongly significant relationship with total length at the smaller size class of 150-200 cm length. However, in the highest size class of 250-300 cm length (large adult males), morphological traits were no longer significantly related with total length. Male crocodiles demonstrated allometric growth of cranial morphology with significantly greater increase in cranial width, snout width, and mid-snout width relative to total length at higher size classes. Morphological dimorphism and allometric growth may be associated with adaptive strategies for reproductive success.

Noto, C.R., Main, D.J. and Drumheller, S.K. (2012). Feeding traces and paleobiology of a Cretaceous (Cenomanian) crocodyliform: example from the Woodbine Formation of Texas. Palaios 27(2): 105-115.

Abstract: Direct evidence of behavior in extinct tetrapods is rare. However, these traces can inform a variety of research questions touching on paleoecology, taphonomy, and functional morphology. Here we present fossil specimens from the Upper Cretaceous (Cenomanian) Woodbine Formation that exhibit tooth marks consistent with predation by a new taxon of large crocodyliform currently under study. Collected from the recently discovered Arlington Archosaur Site, the marked bones were largely found in a single peat horizon and in close association with the new crocodyliform. The feeding traces themselves consist of pits, scores, and punctures that occur on multiple turtle shell fragments and two dinosaur limb bones. The pattern of marks and the breakage on turtle carapaces and plastra suggest that they were crushed, whereas the marks on dinosaur bones indicate possible dismemberment. These interpretations and the association with a crocodyliform trace maker are based on observations of feeding behaviors and accompanying, diagnostic bite mark patterns made by extant crocodylians. The morphology of the new crocodyliform taxon and the distribution of bite marks indicates it was likely a generalist: an opportunistic predator that fed on a variety of prey, including turtles and dinosaurs. Given this evidence and the paleoenvironmental setting, the ecology of the large crocodyliform from the Woodbine Formation was likely most similar to that of fossil and living crocodylians inhabiting delta-plain environments. Not only were these crocodyliforms likely significant predators in the Woodbine paleoecosystem, they also played an important

taphonomic role in the assembly of vertebrate remains from the surrounding community.

Hermes-Lima, M., Carreiro, C., Moreira, D.C., Polcheira, C., Machado, D.P. and Campos, E.G. (2012). Glutathione status and antioxidant enzymes in a crocodilian species from the swamps of the Brazilian Pantanal. Comp. Biochem. Physiol. Part A. Mol. Integ. Physiol. (dx.doi.org/10.1016/j.cbpa.2012.06.006).

Abstract: In a previous study oxidative damage markers - lipid peroxidation and protein oxidation - were determined in organs of wild *Caiman yacare* captured in winter-2001 and summer-2002 at various developmental stages. An increase in oxidative damage occurred in the hatchling-juvenile transition (but not in the juvenile-adult transition) and winter-summer transition (in juveniles), suggesting that oxidative stress is associated with development and season. Herein the effect of development and season on glutathione (GSH) metabolism and the effect of development on the activity of antioxidant enzymes (catalase, glutathione peroxidase, glutathione reductase and glutathione S-transferase) and glucose 6-phosphate dehydrogenase were analyzed. The ratio GSSG:GSH-eq increased in lung, liver, kidney and brain by 1.8- to 4-fold in the embryo/hatchling to juvenile transition. No changes occurred in juvenile-adult transition. GSSG:GSH-eq across seasons was significantly elevated in summer. Total-glutathione content was mostly stable in various organs; in liver it increased in the embryo–juvenile transition. Enzyme activities were only determined in summer-animals (embryos, hatchlings and juveniles). For most antioxidant enzymes, activities increased from embryo/hatchling to juvenile in liver and brain. In lung, there was an inverse trend for enzyme activities and total glutathione content. Thus, increased metabolic rates during early caiman growth - in embryo-juvenile transition - appears to be related to redox imbalance as suggested by increased GSSG:GSH-eq and activation of antioxidant defenses. Differences in oxidative stress across seasons were related with summer-winter nocturnal temperatures.

He, K., Chen, H., Wang, X., Wan, Q. and Fang, S. (2012). A bacterial artificial chromosome library for the Chinese alligator (*Alligator sinensis*). Gene (dx.doi.org/10.1016/j.gene.2012.06.035).

Abstract: Chinese alligator (*Alligator sinensis*) is a rare and endangered species endemic to China. To better understand genetic details of the Chinese alligator genomic structure, a highly redundant BAC library was constructed. This library consists of 216,238 clones with an average insert size of about 90 kb, indicating that the library contains 6.8-fold genome equivalents. Subsequently, we constructed a 516 kb contig map for the Chinese alligator olfactory receptor (OR) genes, which spanned nine BAC clones, and subjected the BACs to full sequencing. The sequence analysis revealed that this contig contained 16 OR functional genes and meanwhile demonstrated that the 9 BACs, which constituted the contig, overlapped correctly, proving the usability of this genome library. As a result, this BAC library could provide a useful platform for physical mapping, genome sequencing or complex analysis of targeted genomic regions for this rare species.

Barbarán, F.R. (2011). Manual de evaluación de sostenibilidad del comercio de fauna. Experiencia en el Chaco Semiárido Argentino. ISBN 978-3-8473-5156-6. Editorial Académica Española. 400 pp. (https://www.morebooks.de/store/es/book/manual-de-evaluaci%C3%B3n-de-sostenibilidad-del-comercio-de-fauna/isbn/978-3-8473-5156-6).

Kumar, A., Kumar, S., Zaidi, Y.F. and Kanaujia, A. (2012). A Review on Status and Conservation of Saltwater Crocodile (*Crocodylus porosus*) in India. Pp. 141-148 *in* 22 May 2012. International Day for Biological Diversity, Marine Diversity. Uttar Pradesh State Biodiversity Board: Lucknow.

Stadler, A.M., Garvey, C.J., Bocahut, A, Sacquin-Mora, S., Digel, I., Schneider, G.J., Natali, F., Artmann, G.M. and Zaccai, G. (2012). Thermal fluctuations of haemoglobin from different species: adaptation to temperature via conformational dynamics. Journal of the Royal Society (doi: 10.1098/rsif.2012.0364).

Abstract: Thermodynamic stability, configurational motions and internal forces of haemoglobin (Hb) of three endotherms (platypus, *Ornithorhynchus anatinus*; domestic chicken, *Gallus gallus domesticus* and human, *Homo sapiens*) and an ectotherm (saltwater crocodile, *Crocodylus porosus*) were investigated using circular dichroism, incoherent elastic neutron scattering and coarse-grained Brownian dynamics simulations. The experimental results from Hb solutions revealed a direct correlation between protein resilience, melting temperature and average body temperature of the different species on the 0.1 ns time scale. Molecular forces appeared to be adapted to permit conformational fluctuations with a root mean square displacement close to 1.2 A at the corresponding average body temperature of the endotherms. Strong forces within crocodile Hb maintain the amplitudes of motion within a narrow limit over the entire temperature range in which the animal lives. In fully hydrated powder samples of human and chicken, Hb mean square displacements and effective force constants on the 1 ns time scale showed no differences over the whole temperature range from 10 to 300 K, in contrast to the solution case. A complementary result of the study, therefore, is that one hydration layer is not sufficient to activate all conformational fluctuations of Hb in the pico- to nanosecond time scale which might be relevant for biological function. Coarse-grained Brownian dynamics simulations permitted to explore residue-specific effects. They indicated that temperature sensing of human and chicken Hb occurs mainly at residues lining internal cavities in the β-subunits.

Mumcuoglu, K.Y. (2012). Mortality of Nile crocodile

(*Crocodylus niloticus*) eggs caused by the Floor Beetle (*Tribolium castaneum*). Open Journal of Veterinary Medicine 2: 9-12.

Abstract: It is estimated that quarter to half a million specimens of the Nile crocodile (*Crocodylus niloticus* Laurenti, 1768) live in liberty. Ranching crocodiles for their skins has been successfully implemented in several African countries but also in Israel. Recently, in one of these ranches, an increased mortality of crocodile eggs was observed and it was thought that insects were causing their death. Two crocodile eggs were kept together with 100 adults of *Tribolium castaneum* (Herbst, 1797), while the third egg was kept without beetles. No food for beetles was added to the boxes. The eggs were observed twice a month for any kind of changes on their surface. After two months, at least 39 holes were observed in one egg and 146 on the second egg, which was exposed to beetles, while no holes could be seen in the control egg. Some of the holes were deep enough to see the inner layers of the egg. There is enough evidence to believe that adults of *T. castaneum* are able to damage the eggs of the Nile crocodile and in some cases lead to their death; measures should be taken to protect the eggs from this and similar species of beetles.

Tee, T.N., Ikpa, T.F and Tortange, V. (2012). Bush meat trade in Makurdi Metropolis; implications for the conservation of wildlife in Nigeria. Journal of Applied Biosciences 52: 3704-3715.

Abstract: To examine how bush meat trading processes could be adapted as a conduit for tackling the threatening disappearance of wildlife resources from their habitat in Nigeria. Bush meat trade species in Makurdi metropolis were identified, and their sources and channels of trade and profitability determined through participatory market survey techniques. Applying a multistage sampling technique, 179 bush meat traders were identified and their trading activities monitored between February and August, 2010. Data were analysed on Excel and SPSS 14.0 software version. Fourteen bush meat species obtained from protected areas in Bauchi, Cross-River and Taraba states; over 300 km away from the metropolis, were identified and 6074 dry bush meat carcasses were traded over the study period. The bush meat trade, channelling from primary suppliers through middlemen to the ultimate consumers was profitable. Bush meat is widely consumed in Makurdi metropolis, and the numerous bush meat carcasses traded depicts the existent exploitation pressure on wildlife; and threat to their sustainability. Bush meat supply to Makurdi comes primarily from adjoining protected areas outside the state through illegal hunters and other forest products' harvesters. The channels of bush meat trade perform the distributive functions, and this comprise of the primary producers, the middlemen, and the ultimate consumers. The profitability of bush meat trade in Makurdi metropolis propels bush meat traders to remain in business. This has increased pressure on wildlife harvests for trade and hence threats to their sustainability. Governments and other development agents should use information supplied here to plan for a sustainable system that will optimize people's livelihoods and also maintain wildlife populations. Providing affordable and acceptable alternative sources of income and protein, promoting selective/exclusive hunting, and controlling access to complicated weapons are recommended policy options.

Obioha, E.E., Isiugo, P.N., Jimoh, S.O., Ikyaagba, E., Ngoufo, R., Serge, B.K. and Waltert, M. (2012). Bush meat harvesting and human subsistence nexus in the Oban Hill communities of Nigeria. J. Hum. Ecol. 38(1): 49-64.

Abstract: Wildlife is an important socio-cultural and economic resource in West and Central Africa. The declining wildlife population in the recent time is as a result of a combination of factors, namely, increased access and demand for wildlife resources by rural and urban dwellers, population growth, improved hunting technology and lack of protein alternatives in many households.. This paper investigates the contribution of bush meat extraction to household's livelihood (income, health, nutrition, etc.); the role of beliefs and taboos in wildlife conservation and the attitude of community members towards wildlife hunting and conservation in Oban Hills, Nigeria. Data for the study were generated through a triangulation of qualitative and quantitative methods using primary and secondary sources. It was revealed that majority of the people of Oban Hills are farmers although some also engaged in quarry business, civil service, trading, lumbering and hunting. However, there has been a decline in income generated from hunting and dependence on bush meat as protein source due to restrictions on hunting in and around forests in the protected area. It was also observed that beliefs and taboos in form of totems played a major role in wildlife conservation in the past; therefore involving existing cultural institutions in conservation efforts will facilitate sustainable wildlife exploitation in Oban Hills. However, the involvement of the cultural institution in the conservation agenda and the integration of these values into the overall conservation strategy will be achieved through a formal process of recognition and consultation by the responsible government agencies.

Crawford, N.G., Faircloth, B.C., McCormack, J.E., Brumfield, R.T., Winkers, K. and Glenn, T.C. (2012). More than 1000 ultraconserved elements provide evidence that turtles are the sister group of archosaurs. Biology Letters (doi: 10.1098/rsbl.2012.0331).

Abstract: We present the first genomic-scale analysis addressing the phylogenetic position of turtles, using over 1000 loci from representatives of all major reptile lineages including tuatara. Previously, studies of morphological traits positioned turtles either at the base of the reptile tree or with lizards, snakes and tuatara (lepidosaurs), whereas molecular analyses typically allied turtles with crocodiles and birds (archosaurs). A recent analysis of shared microRNA families found that turtles are more closely related to lepidosaurs. To test this hypothesis with data from many single-copy nuclear loci dispersed throughout the genome, we used sequence

capture, high-throughput sequencing and published genomes to obtain sequences from 1145 ultraconserved elements (UCEs) and their variable flanking DNA. The resulting phylogeny provides overwhelming support for the hypothesis that turtles evolved from a common ancestor of birds and crocodilians, rejecting the hypothesized relationship between turtles and lepidosaurs.

Bennett, G.E., III. (2012). Community structure and paleoecology of crocodyliforms from the upper Hell Creek Formation (Maastrichtian), eastern Montana, based on shed teeth. Jeffersoniana 28: 1-15.

Abstract: Modern crocodilian populations display a distinct attritional age class frequency distribution, with each age class corresponding roughly to size. Hatchlings constitute the largest age class, with each successive age class containing fewer individuals. This pattern reflects the continuous growth and natural mortality rate in crocodilians. Screen washing of microvertebrate localities in the upper Hell Creek Formation of eastern Montana has produced several hundred shed crocodyliform teeth. Two dominant species of Hell Creek crocodyliforms, *Borealosuchus sternbergii* and *Brachychampsa montana*, possess indistinguishable anterior teeth and have been combined in this study. The sample of shed teeth represents a temporally averaged and spatially constrained assemblage, whereby the effects of stochastic events that affected hatching rates in the original populations during a single season are muted. Using a modeled population and measured tooth replacement rates through ontogeny of the extant *Alligator mississippiensis*, it was found that both the extant and extinct crocodyliforms studied shed proportionally similar numbers of teeth in each size category into the environment. Results indicate that: (1) the size and age structures of ancient and extant crocodyliform communities are similar; (2) microvertebrate localities in channel sands are size-sorted and should be used with caution in studies of population demographics; and (3) using unbiased collecting techniques, the community structures of other extinct vertebrates that lack modern analogues can be established.

Poore, G.C.B. (2012). The nomenclature of the Recent Pentastomida (Crustacea), with a list of species and available names. Systematic Parasitology 82(3): 211-240.

Abstract: The taxonomy of the Recent members of the crustacean subclass Pentastomida is based on nine accepted family names derived from 12 available names, 24 generic names derived from 37 available names (plus two incorrect subsequent spellings and one *nomen nudum*) and 124 accepted species names derived from 183 available names of which 6 remain incertae sedis as to their generic assignment. Compilation of this list has revealed that existing catalogues have included misspellings, wrong attributions and dates of the authors of taxa, and incorrectly nominated type-species. These are corrected here with reference to the original descriptions and diagnoses. Notably, all families except one were erected much earlier and by authors other than Fain (1961), who was credited by Martin & Davis (2001) and other authors before and afterwards with 7 of the 9 families they recognised. Other significant taxonomic anomalies are revealed. Raillietiellidae Sambon, 1922 is a senior synonym of Cephalobaenidae Heymons, 1922, the name in popular usage for the family including Cephalobaena Heymons, 1922 and Raillietiella Sambon, in Vaney & Sambon, 1910; here the two genera are placed in separate families following Almeida & Christoffersen (1999). Heymonsia Hett, 1934, considered a junior synonym of *Raillietiella*, is a *nomen nudum*. *Raillietiella geckonis* (Diesing, 1850) is a potential senior synonym of several SE Asian species of this genus. *Raillietiella frenata* Ali, Riley & Self, 1981 is a widely used species name but is a subjective junior synonym of *R. hebitihamata* Self & Kuntz, 1960 according to its own authors. Morphological and molecular evidence suggest that *R. indica* Gedoelst, 1921 is a subjective senior synonym of both species. The priority of Linguatulidae Haldeman, 1851 over Linguatulida Vogt, 1851, erected as a family in the same year, is established by applying the First Reviser rule. *Linguatula serrata* Frölich, 1789 is herein selected as the type-species of *Prionoderma*, making it an objective synonym of *Linguatula* Frölich, 1789. The priority of *L. serrata* over *Taenia rhinaris* Meyer, 1789 and *T. capraea* Abildgaard, 1789, all published in the same year, is established by applying the First Reviser rule. The purported synonymy of *Netrorhynchus* Zenker, 1827, also misspelled *Nettorhynchus*, with *Armillifer* Sambon, 1922 would seem to be ill-founded and without popular support. *Armillifer australis* Heymons, 1935, published as a subspecies of *A. moniliformis* (Diesing, 1836), is both a senior synonym and a homonym of *A. australis* Riley & Self, 1981. Humboldt (1812) is confirmed as the author of *Porocephalus* Humboldt, 1812 and *P. crotali* Humboldt, 1812. Pentastomidae Shipley, 1909 is an older family name than its subjective synonym Porocephalinae Sambon, 1922, but prevailing usage allows the latter to be retained as a family name. *Cayerina mirabilis* Kishida, 1927 is a genus and species from a Japanese frog that has not appeared in the more recent pentastome literature. *Sebekia minor* (Wedl, 1861) is an objective senior synonym of the more widely used *S. wedli* Gigioli, in Sambon, 1922. The importance of the many junior synonyms will become evident should refined morphological and molecular evidence reveal cryptic species or greater host-specificity than presently recognised.

Hao, J., Lia, Y., Xie, M. and Li, A. (2012). Molecular cloning, recombinant expression and antibacterial activity analysis of hepcidin from Siamensis crocodile (*Crocodylus siamensis*). Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology (dx.doi.org/10.1016/j.cbpb.2012.08.002).

Abstract: Hepcidin, a cysteine-rich cationic antibacterial peptide, plays an important role in human defense against pathogen infection. However, its role in reptile immune response and whether it is involved in antibacterial immune have not yet been proven. In order to study the antibacterial activity of *Crocodylus siamensis* hepcidin (Cshepc), a common reptile which lives in topic region of Southeast

Asia, a cDNA sequence of Cshepc was cloned, which included an open reading frame (ORF) of 300 bp encoding a 99 amino acid preprohepcidin. Cshepc has 8 cysteines formed 4 conserved disulfide bridges, similarly to that of human's. Sequence analysis showed that Cshepc mature peptide was more conserved than that of preprohepcidin. Tissue expression analysis indicated that Cshepc transcripts were highly expressed in the liver, muscle and heart of *C. siamensis*. Recombinant expressed hepcidin could significantly inhibit the growth of the Gram-negative bacteria *Escherichia coli* and *Aeromonas sobria* as well as the Gram-positive bacterium *Staphylococcus aureus*, and *Bacillus subtilis in vitro*, suggesting that Cshepc, like human hepcidin could play a role in the antibacterial function in hosts innate immune response.

Nair, T., Thorbjarnarson, J.B., Aust, P. and Krishnaswamy, J. (2012). Rigorous gharial population estimation in the Chambal: implications for conservation and management of a globally threatened crocodilian. Journal of Applied Ecology (doi: 10.1111/j.1365-2664.2012.02189.x).

Abstract: India's Chambal River hosts the largest population of the critically endangered gharial. Boat-based daylight surveys to date only provide indices of relative abundance, without measures of survey bias or error. No attempt to quantify detection probabilities in these surveys has yet been made, and thus, absolute density estimates of this population remain unknown. We surveyed 75 km of the Chambal River and photographed individual gharials for capture-recapture analysis. The total sampling effort yielded 400 captures. Population closure was supported (z= 1 48, P= 0 069), and closed-population models were used to estimate abundances. Models were selected using the Akaike Information Criterion (AIC) index of model fit. The best model estimated 231 ± 32 adult, 83 ± 23 subadult and 89 ± 19 juvenile gharials (mean ± SE), respectively, while the model-averaged estimate was 220 ± 28 adult, 76 ± 16 subadults and 93 ± 16 juvenile gharials, respectively. The best model estimated absolute densities of 3.08 ± 0.43, 1.11 ± 0.3 and 1.19 ± 0.25 adult, subadult and juvenile gharials/km, respectively, while the model-averaged estimate was 2.93 ± 0.37, 1.01 ± 0.21 and 1.24 ± 0.21 adult, subadult and juvenile gharials/km, respectively, compared with relative densities of 0.94, 0.45 and 0.30 adult, subadult and juvenile gharials/km, respectively, from boat-based daylight surveys. On the basis of our best model, we suggest a detection probability based correction factor of 3.27, 2.47 and 3.97 to boat-based daylight survey estimates of adult, subadult and juvenile gharials, respectively. Synthesis and applications. Used within the framework of capture-recapture analysis, photoidentification provides a reliable and noninvasive method of estimating population size and structure in crocodilians. We also opine that without determining the current status of gharials, highly intensive strategies, such as the egg-collection and rear-and-release programmes being implemented currently, initiated on the basis of underestimates of population sizes, are unwarranted and divert valuable conservation resources away from field-based protection measures, which are essential in the face of threats like hydrologic diversions, sand mining, fishing and bankside cultivation.

Myburgh, J.G., Huchzermeyer, F.W., Soley, J.T., Booyse, D.G., Groenewald, H.B., Bekker, L.C., Iguchi, T. and Guillette Jr., L.J. (2012). Technique for the collection of clear urine from the Nile crocodile (*Crocodylus niloticus*). Journal of the South African Veterinary Association 83: 1-6.

Abstract: Urine samples can be a very useful diagnostic tool for the evaluation of animal health. In this article, a simple technique to collect urine from the Nile crocodile (*Crocodylus niloticus*) was described, based on a similar unpublished technique developed for the American alligator (*Alligator mississippiensis*) using a canine urinary catheter. With this technique, it was possible to collect relatively clean urine samples from Nile crocodiles of different sizes using canine urinary catheters or small diameter stomach tubes. Based on the gross anatomical features of the cloaca of the Nile crocodile, it was confirmed that urine accumulates in a chamber consisting of the urodeum and coprodeum. Faecal material is stored temporarily in the very short rectum, which is separated from the urinary chamber by the rectocoprodeal sphincter.

Canto, A.C., Lima, B.R., Cruz, A.G., Lázaro, C.A., Freitas, D.G., Faria, J.A., Torrezan, R., Freitas, M.Q. and Silva, T.P. (2012). Effect of high hydrostatic pressure on the color and texture parameters of refrigerated caiman (*Caiman crocodilus yacare*) tail meat. Meat Sci. 91(3): 255-60.

Abstract: The effect of applying high hydrostatic pressure (HHP) on the instrumental parameters of color and texture and sensory characteristics of alligator meat were evaluated. Samples of alligator tail meat were sliced, vacuum-packed, pressurized and distributed into four groups: control, treated with 200 MPa/10 min, 300 MPa/10 min and 400 MPa/10 min, then stored at 4°C±1°C for 45 days. Instrumental color, texture profile and a sensory profiling using quantitative descriptive analysis were carried out on the 1st, 15th, 30th and 45th days of storage. HHP was shown to affect the color and texture of the product, and the sensory descriptors ($p<0.05$). The results suggest that high pressure is a promising technology for the processing of alligator meat, especially low pressures (200 MPa) which can have positive effects on the quality of the product.

Aree, K., Siruntawineti, J. and Chaeychomsri, W. (2011). C*rocodylus siamensis* serum and macrophage phagocytic activity. J. Med. Assoc. Thai. 94 Suppl. 7: S131-138.

Abstract: Antimicrobial activity of sera from many crocodilian species has been recognized. This activity was proposed to be mediated, at least in part, by complement. Due to the fact that complement proteins have different functions in the immune system, they may be involved in phagocytic process of phagocytes. In the present study, the effects of Siamese crocodile serum on phagocytic activity of macrophages

as well as the possible involvement of complement in this process were examined. The results showed increases in the phagocytosis of both *Escherichia coli* and to a lesser extent, *Staphylococcus aureus* upon incubation of murine macrophage cell line with fresh crocodile serum (FS). Similar to FS, other crocodile blood products, including freeze dried serum (DS) and freeze dried whole blood (DWB) exhibited phagocytosis-enhancing property. However the ability of DWB to enhance phagocytosis was less efficient than that of FS and DS, suggesting that serum factors were involved in this process. Treatment of FS with heat at 56 degrees C for 30 min deteriorated the effect of FS on bacterial uptake of macrophages, suggesting that complement proteins play a role in the modulation of the phagocytic process. Collectively, the results of the present study suggested that crocodile serum enhances the macrophage phagocytic activity through complement activity and, therefore, may be taken as an alternative medicine for supporting the human immune responses.

Kasai, F., O'Brien, P.C., Martin, S. and Ferguson-Smith, M.A. (2012). Extensive homology of chicken macrochromosomes in the karyotypes of *Trachemys scripta elegans* and *Crocodylus niloticus* revealed by chromosome painting despite long divergence times. Cytogenet. Genome Res. 136(4): 303-307.

Abstract: We report extensive chromosome homology revealed by chromosome painting between chicken (*Gallus gallus domesticus*, GGA, 2n = 78) macrochromosomes (representing 70% of the chicken genome) and the chromosomes of a turtle, the red-eared slider (*Trachemys scripta elegans*, TSC, 2n = 50), and the Nile crocodile (*Crocodylus niloticus*, CNI, 2n = 32). Our data show that GGA1-8 arms seem to be conserved in the arms of TSC chromosomes, GGA1-2 arms are separated and homologous to CNI1p, 3q, 4q and 5q. In addition to GGAZ homologues in our previous study, large-scale GGA autosome syntenies have been conserved in turtle and crocodile despite hundreds of millions of years divergence time. Based on phylogenetic hypotheses that crocodiles diverged after the divergence of birds and turtles, our results in CNI suggest that GGA1-2 and TSC1-2 represent the ancestral state and that chromosome fissions followed by fusions have been the mechanisms responsible for the reduction of chromosome number in crocodiles.

Serna-Lagunes, R. and Díaz-Rivera P., G.D (2012). Genetic variability in captive populations of *Crocodylus moreletii* (Crocodylia: Crocodylidae) using microsatellites markers. Rev Biol Trop. 60(1): 425-36.

Abstract: *Crocodylus moreletii,* an extinction threatened species, represents an emblem for tropical ecosystems in Mexico. Surprisingly, there is a lack of information about their genetic constitution, which should be evaluated for a proper management ex situ and for making decisions on the release of crocodiles into natural habitats. The aim of this study was to characterize and compare the genetic variability of four populations of *C. moreletii* (two wild versus two born *ex situ*). Through PCR were amplified seven microsatellite polymorphic loci, however a heterozygote deficit, diminished by the presence of null alleles, was found in the populations (average Ho= 0.02). The AMOVA indicated that the highest proportion of genetic variability is within populations, and a limited genetic differentiation among populations (average F(ST)= 0.03), probably due to high inbreeding index (average F(IS)= 0.97). When comparing the genetic variability between and within other crocodilian species, we found that in *C. moreletii* is well below those reported. We concluded that the limited genetic variability in ex situ born populations is probably due to a founder effect derived from the social structure of their progenitors, and by the bottleneck effect, inferred by the limited effective population size, that historically characterizes their natural distribution in wild populations.

Song, W., Shen, D.Y., Kang, J.H., Li, S.S., Zhan, H.W., Shi, Y., Xiong, Y.X., Liang, G. and Chen, Q.X. (2012). Apoptosis of human cholangiocarcinoma cells induced by ESC-3 from *Crocodylus siamensis* bile. World J. Gastroenterol. 18(7): 704-711.

Abstract: Aim- To investigate the effects of ESC-3 isolated from crocodile bile on the growth and apoptosis induction of human cholangiocarcinoma cells. Methods- ESC-3 was isolated from crocodile bile by Sephadex LH-20 and RP-18 reversed-phase column. 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium bromide assay was conducted to determine the effects of ESC-3 on the proliferation of human cholangiocarcinoma cell lines (QBC939, Sk-ChA-1 and MZ-ChA-1). Giemsa staining, Hoechst 33258 and acridine orange/ethidium bromide staining showed the morphological changes of Mz-ChA-1 cells exposed to ESC-3 at different concentrations. Flow cytometry with regular propidium iodide (PI) staining was performed to analyze the cell cycle distribution of Mz-ChA-1 cells and to assess apoptosis by annexin v-fluorescein isothiocyanate (V-FITC)/PI staining. Rh123 staining was used to detect the alteration of mitochondrial membrane potential ($\Delta\Psi m$). The protein levels of Bax, Bcl-2, Cdk2, cytochrome c and caspase-3 were further confirmed by Western blotting. Results- ESC-3 significantly inhibited the growth of three human cholangiocarcinoma cell lines and arrested Mz-ChA-1 cell cycle at G0/G1 phase. Mz-ChA-1 cells showed typical apoptotic morphological changes after treated with ESC-3 (10 μg/mL) for 48 h. Cell death assay indicated that Mz-ChA-1 cells underwent apoptosis in a dose-dependent manner induced by ESC-3. In addition, ESC-3 treatment could downregulate the protein level of Bcl-2 and upregulate the Bax, leading to the increase in the ratio of Bax to Bcl-2 in Mz-ChA-1 cells. Meanwhile, cytochrome c was released from the mitochondria into the cytosol, which subsequently initiated the activation of caspase-3. All these events were associated with the collapse of the mitochondrial membrane potential. Conclusion- ESC-3, the active ingredient of crocodile bile, induced apoptosis in Mz-ChA-1 cells through the mitochondria-dependent pathway and may be a potential chemotherapeutic drug for the treatment of cholangiocarcinoma.

Bagatto, B., Crossley, D.A. II., Altimiras, J., Elsey, R.M. and Hicks, J.W. (2012). Physiological variability in yearling alligators: clutch differences at rest and during activity. Comp. Biochem. Physiol. A Mol. Integr. Physiol. 62(1): 44-50.

Abstract: The adult phenotype of an organism is the result of its genotype, the environment, and the interaction between the two. Assessing the relative contribution of these factors to the final adult phenotype continues to occupy researchers. Studies have shown clutch effects early in development but few have investigated the persistence of clutch effects on a longer time scale. Five clutches of American alligators were reared for 1 year in a common environment then assessed for the presence of clutch effects as they related to morphological and physiological characteristics. After 1 year, significant clutch effects were evident in all size related variables despite open access to food. Additionally, lung and liver masses remained different between clutches after animal mass was taken into account. Although clutch had no effect on resting heart rate, it significantly contributed to mean arterial pressure. During swimming and exhaustive exercise, the resulting respiratory and metabolic acidoses were strongly dependent on clutch. Therefore, while the environment can have significant influences on the American alligator from hatching to death, the measureable contribution of genetics to the morphology and physiology of the organism remains evident, even after 1 year of common rearing conditions. It behooves researchers to acknowledge and control for clutch effects when designing experiments.

Leslie, A.J., Lovely, C.J. and Pittman, J.M. (2011). A preliminary disease survey in the wild Nile crocodile (*Crocodylus niloticus*) population in the Okavango Delta, Botswana. J. S. Afr. Vet. Assoc. 82(3): 155-159.

Abstract: The objective of this study was to conduct a preliminary survey of diseases that might be present in the wild Nile crocodile population in the Okavango Delta, Botswana. Blood samples were collected from crocodiles ranging in size from 34.0 cm to 463.0 cm total length. Samples were examined for blood parasites and underwent a haematological analysis. Before release the crocodiles were examined for various clinical abnormalities. Of the 144 crocodiles examined, none were visibly sick or displayed any signs of disease. No antibodies to *Mycoplasma crocodyli* were detected. *Hepatozoon pettiti* was present in 55.3% of blood smears examined, but there was no significant difference in any of the haematological values between the infected and uninfected crocodiles, and a high prevalence of *Hepatozoon* infection is not uncommon in other species. Only 7.6% of the examined crocodiles were infested with leeches. Further research is required for several of the crocodilian diseases, in particular to elucidate the role of wild crocodilians as reservoirs of infection.

Munns, S.L., Owerkowicz, T., Andrewartha, S.J. and Frappell, P.B. (2012). The accessory role of the diaphragmaticus muscle in lung ventilation in the estuarine crocodile *Crocodylus porosus*. J. Exp. Biol. 215(5): 845-852.

Abstract: Crocodilians use a combination of three muscular mechanisms to effect lung ventilation: the intercostal muscles producing thoracic movement, the abdominal muscles producing pelvic rotation and gastralial translation, and the diaphragmaticus muscle producing visceral displacement. Earlier studies suggested that the diaphragmaticus is a primary muscle of inspiration in crocodilians, but direct measurements of the diaphragmatic contribution to lung ventilation and gas exchange have not been made to date. In this study, ventilation, metabolic rate and arterial blood gases were measured from juvenile estuarine crocodiles under three conditions: (i) while resting at 30°C and 20°C; (ii) while breathing hypercapnic gases; and (iii) during immediate recovery from treadmill exercise. The relative contribution of the diaphragmaticus was then determined by obtaining measurements before and after transection of the muscle. The diaphragmaticus was found to make only a limited contribution to lung ventilation while crocodiles were resting at 30°C and 20°C, and during increased respiratory drive induced by hypercapnic gas. However, the diaphragmaticus muscle was found to play a significant role in facilitating a higher rate of inspiratory airflow in response to exercise. Transection of the diaphragmaticus decreased the exercise-induced increase in the rate of inspiration (with no compensatory increases in the duration of inspiration), thus compromising the exercise-induced increases in tidal volume and minute ventilation. These results suggest that, in *C. porosus*, costal ventilation alone is able to support metabolic demands at rest, and the diaphragmaticus is largely an accessory muscle used at times of elevated metabolic demand.

Holliday, C.M. and Gardner, N.M. (2012). A new eusuchian crocodyliform with novel cranial integument and its significance for the origin and evolution of Crocodylia. PLoS One 7(1): e30471.

Abstract: Crocodyliforms were one of the most successful groups of Mesozoic tetrapods, radiating into terrestrial, semiaquatic and marine environments, while occupying numerous trophic niches, including carnivorous, insectivorous, herbivorous, and piscivorous species. Among these taxa were the enigmatic, poorly represented flat-headed crocodyliforms from the late Cretaceous of northern Africa. Here we report a new, giant crocodyliform from the early Late Cretaceous (Cenomanian) Kem Kem Formation of Morocco. Represented by a partial braincase, the taxon has an extremely long, flat skull with large jaw and craniocervical muscles. The skull roof is ridged and ornamented with a broad, rough boss surrounded by significant vascular impressions, likely forming an integumentary structure unique among crocodyliforms. Size estimates using endocranial volume indicate the specimen was very large. The taxon possesses robust laterosphenoids with laterally oriented capitate processes and isolated epipterygoids, features allying it with derived eusuchians. Phylogenetic analysis finds the taxon to be a derived eusuchian and sister taxon to *Aegyptosuchus*,

a poorly understood, early Late Cretaceous taxon from the Bahariya formation. This clade forms the sister clade of crown-group Crocodylia, making these taxa the earliest eusuchian crocodyliforms known from Africa. These results shift phylogenetic and biogeographical hypotheses on the origin of modern crocodylians towards the circum-Tethyean region and provide important new data on eusuchian morphology and evolution

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Sanders, R.K. and Farmer, C.G. (2012). The pulmonary anatomy of *Alligator mississippiensis* and its similarity to the avian respiratory system. Anat. Rec. (Hoboken) 295(4): 699-714.

Abstract: Using gross dissections and computed tomography we studied the lungs of juvenile American alligators (*Alligator mississippiensis*). Our findings indicate that both the external and internal morphology of the lungs is strikingly similar to the embryonic avian respiratory system (lungs + air sacs). We identified bronchi that we propose are homologous to the avian ventrobronchi (entobronchi), laterobronchi, dorsobronchi (ectobronchi), as well as regions of the lung hypothesized to be homologous to the cervical, interclavicular, anterior thoracic, posterior thoracic, and abdominal air sacs. Furthermore, we suggest that many of the features that alligators and birds share are homologous and that some of these features are important to the aerodynamic valve mechanism and are likely plesiomorphic for Archosauria.

Hall, N.H., Conley, K., Berry, C., Farina, L., Sigler, L., Wellehan, J.F. Jr., Roehrl, M.H. and Heard, D. (2011). Computed tomography of granulomatous pneumonia with oxalosis in an American alligator (*Alligator mississippiensis*) associated with *Metarhizium anisopliae* var *anisopliae*. J. Zoo Wildl. Med. 42(4): 700-708.

Abstract: An 18-yr-old, male, albino, American alligator (*Alligator mississippiensis*) was evaluated for decreased appetite and abnormal buoyancy. Computed tomography (CT) of the coelomic cavity showed multifocal mineral and soft tissue attenuating pulmonary masses consistent with pulmonary fungal granulomas. Additionally, multifocal areas of generalized, severe emphysema and pulmonary and pleural thickening were identified. The alligator was euthanized and necropsy revealed severe fungal pneumonia associated with oxalosis. *Metarhizium anisopliae* var. *anisopliae* was cultured from lung tissue and exhibited oxalate crystal formation in vitro. Crystals were identified as calcium oxalate monohydrate by X-ray powder defractometry. Fungal identification was based on morphology, including tissue sporulation, and DNA sequence analysis. This organism is typically thought of as an entomopathogen. Clinical signs of fungal pneumonia in nonavian reptiles are often inapparent until the disease is at an advanced stage, making antemortem diagnosis challenging. This case demonstrates the value of CT for pulmonary assessment and diagnosis of fungal pneumonia in the American alligator. Fungal infection with associated oxalosis should not be presumed to be aspergillosis.

Davis, A.K., Horan, R.V. III., Grosse, A.M., Harris, B.B., Metts, B.S., Scott, D.E. and Tuberville, T.D. (2011). Gender differences in haemogregarine infections in American alligators (*Alligator mississippiensis*) at Savannah River, South Carolina, USA. J. Wildl. Dis. 47(4): 1047-1049.

Abstract: We report a host gender bias in haemogregarine infection characteristics in the American alligator (*Alligator mississippiensis*) at the Savannah River Site, South Carolina, USA. Prevalence and severity in female alligators was higher than it was in males. The reason for this pattern is not clear.

Jandaruang, J., Siritapetawee, J., Thumanu, K., Songsiriritthigul, C., Krittanai, C., Daduang, S., Dhiravisit, A. and Thammasirirak, S. (2012). The effects of temperature and pH on secondary structure and antioxidant activity of *Crocodylus siamensis* hemoglobin. Protein J. 31(1): 43-50.

Abstract: *Crocodylus siamensis* hemoglobin (cHb) was purified by gel filtration chromatography and visualized by SDS-PAGE. Effects of temperature and pH on secondary structure and conformation changes of cHb were studied using circular dichroism spectropolarimeter and fourier transform infrared spectrophotometer. The secondary structure of intact cHb was mainly α-helices. cHb was not heat stable when heated at 65°C and cooled down to original temperature, indicating the irreversible unfolding process. The stability of cHb at different pH ranging from 2.5 to 10.5 was determined. The maximum value of the α-helix content was found at pH 3.5 and tended to decrease at strong acid and strong base. The antioxidant activities of heat treated cHb and cHb in solution with pH range 2.5 to 10.5 were tested by DPPH radical scavenging assay. cHb at pH 4.5, having highest β-turn structure, showed highest radical scavenging activity. In contrast to pH, heat had no effect on antioxidant activity of cHb.

Oaks, J.R. (2011). A time-calibrated species tree of Crocodylia reveals a recent radiation of the true crocodiles. Evolution 65(11): 3285-3297.

Abstract: True crocodiles (*Crocodylus*) are the most broadly distributed, ecologically diverse, and species-rich crocodylian genus, comprising about half of extant crocodylian diversity and exhibiting a circumtropical distribution. *Crocodylus* traditionally has been viewed as an ancient group of morphologically conserved species that originated in Africa prior to continental breakup. In this study, these long-held notions about the temporal and geographic origin of *Crocodylus* are tested using DNA sequence data of 10 loci from 76 individuals representing all 23 crocodylian species. I infer a time-calibrated species tree of all Crocodylia and estimate the spatial pattern of diversification within *Crocodylus*. For the first time, a fully resolved phylogenetic estimate of all Crocodylia is well-supported. The results overturn traditional views of the evolution of *Crocodylus* by demonstrating that the true crocodiles are not "living-fossils" that originated in

Africa. Rather, *Crocodylus* originated from an ancestor in the tropics of the Late Miocene Indo-Pacific, and rapidly radiated and dispersed around the globe during a period marked by mass extinctions of fellow crocodylians. The findings also reveal more diversity within the genus than is recognized by current taxonomy.

Vergne, A.L., Aubin, T., Taylor, P. and Mathevon, N. (2011). Acoustic signals of baby black caimans. Zoology (Jena) 114(6): 313-320.

Abstract: In spite of the importance of crocodilian vocalizations for the understanding of the evolution of sound communication in Archosauria and due to the small number of experimental investigations, information concerning the vocal world of crocodilians is limited. By studying black caimans *Melanosuchus niger* in their natural habitat, here we supply the experimental evidence that juvenile crocodilians can use a graded sound system in order to elicit adapted behavioral responses from their mother and siblings. By analyzing the acoustic structure of calls emitted in two different situations ('undisturbed context', during which spontaneous calls of juvenile caimans were recorded without perturbing the group, and a simulated 'predator attack', during which calls were recorded while shaking juveniles) and by testing their biological relevance through playback experiments, we reveal the existence of two functionally different types of juvenile calls that produce a different response from the mother and other siblings. Young black caimans can thus modulate the structure of their vocalizations along an acoustic continuum as a function of the emission context. Playback experiments show that both mother and juveniles discriminate between these 'distress' and 'contact' calls. Acoustic communication is thus an important component mediating relationships within family groups in caimans as it is in birds, their archosaurian relatives. Although probably limited, the vocal repertoire of young crocodilians is capable of transmitting the information necessary for allowing siblings and mother to modulate their behavior.

Srikulnath, K., Thongpan, A., Suputtitada, S. and Apisitwanich, S. (2012). New haplotype of the complete mitochondrial genome of *Crocodylus siamensis* and its species-specific DNA markers: distinguishing *C. siamensis* from *C. porosus* in Thailand. Mol. Biol. Rep. 39(4): 4709-4717.

Abstract: Based on molecular phylogeny of available complete mitochondrial DNA (mtDNA) genome sequences reveals that *Crocodylus siamensis* and *C. porosus* are closely related species. Yet, the sequence divergence of their mtDNA showed only a few values under conspecific level. In this study, a new haplotype (haplotype2, EF581859) of the complete mtDNA genome of Siamese crocodile (*C. siamensis*) was determined. The genome organization, which appeared to be highly similar to haplotype1 (DQ353946) mtDNA genome of *C. siamensis*, was 16,814 bp in length. However, the sequence divergence between the two genomes differed by around 7-10 and 0.7-2.1% for the haplotype1 between *C. siamensis* and *C. porosus* (AJ810453). These results were consistent with the phylogenetic relationship among the three genomes, suggesting that *C. siamensis* haplotype1 mtDNA genome might be the hybrid or the intraspecific variation of *C. porosus*. On the other hand, our specimen was found to be a true *C. siamensis*. Simultaneously, the seven species-specific DNA markers designed based on the distinctive site between haplotype2 mtDNA sequences of *C. siamensis* and haplotype1 mtDNA sequence of *C. siamensis-C. porosus* were successfully used to distinguish *C. siamensis* from *C. porosus*. These effective markers could be used primarily for rapid and accurate species identification in population, ecology and conservation studies.

Jacobs, K., Goy, S.K. and Dzialowski, E.M. (2012). Morphology of the embryonic and hatchling American alligator ductus arteriosi and implications for embryonic cardiovascular shunting. J. Morphol. 273(2): 186-194.

Abstract: The ductus arteriosi (DA) are embryonic blood vessels found in amniotic vertebrates that shunt blood away from the pulmonary artery and lungs and toward the aorta. Here, we examine changes in morphology of the right and left DA (LDA), and right and left aorta (LAo) from embryonic and hatchling alligators. The developing alligator has two-patent DA that join the right and LAo. Both DA exhibit a muscular phenotype composed of an internal smooth muscle layer (2-4 cells thick). At hatching, the lumen diameter of both DA decreases as the vessels begin to close within the first 12 h of posthatch life. Between day 1 and day 12 posthatching, the vessel becomes fully occluded with endothelial and smooth muscle cells filling the lumen. A number of DA from hatchlings contained blood clots along their length. The lumen of the full term alligator DA is reduced in comparison with the full term chicken DA. The developing alligator embryo has an additional right-to-left shunt pathway in the LAo arising from the right ventricle. The embryonic LAo diameter is twice the diameter of either the right DA or LDA, providing a lower resistance pathway for blood leaving the right ventricle. On the basis of these findings, we propose that the paired DA of the embryonic alligator have a reduced role in the embryonic right-to-left shunt of blood from the right ventricle when compared with the avian DA.

Boggs, A.S., Hamlin, H.J., Lowers, R.H. and Guillette, L.J. Jr. (2011). Seasonal variation in plasma thyroid hormone concentrations in coastal versus inland populations of juvenile American alligators (*Alligator mississippiensis*): influence of plasma iodide concentrations. Gen. Comp. Endocrinol. 174(3): 362-369.

Abstract: Thyroid hormones, essential for normal growth and health, are associated with changes in temperature, photoperiod, and reproduction. Iodide, a necessary element for thyroid hormone production, varies in diet, and is more abundant in estuarine environments, which could alter thyroid hormone variation. However, associations between thyroid hormone concentrations in animals from marine

versus freshwater environments, which could become more pertinent with rising sea levels associated with global climate change, are not well studied. To determine the importance of dietary iodide in seasonal variation of plasma thyroid hormone concentrations, we analyzed seasonal variation of plasma thyroxine (T(4)) and triiodothyronine (T(3)) concentrations in juvenile alligators from an estuarine habitat (Merritt Island National Wildlife Refuge; MI) and a freshwater habitat (Lake Woodruff National Wildlife Refuge; LW) and compared these results to plasma inorganic iodide (PII) concentrations. Alligators from MI did not display seasonal variation in plasma T(4), but exhibited a seasonal pattern in plasma T(3) concentrations similar to alligators from LW. Plasma thyroid hormone concentrations were consistently higher at MI than at LW. PII concentrations were correlated with plasma T(4) and T(3) concentrations in juvenile alligators from LW but not MI. The data on plasma T(4) and T(3) concentrations suggest altered iodide metabolism in estuarine alligators. Differences in thyroid hormone concentrations between the populations could be due to differences in dietary iodide, which need to be further evaluated.

Moore, B.C., Roark, A.M., Kohno, S., Hamlin, H.J. and Guillette, L.J. Jr. (2012). Gene-environment interactions: the potential role of contaminants in somatic growth and the development of the reproductive system of the American alligator. Mol. Cell. Endocrinol. 354(1-2): 111-120.

Abstract: Developing organisms interpret and integrate environmental signals to produce adaptive phenotypes that are prospectively suited for probable demands in later life. This plasticity can be disrupted when embryos are impacted by exogenous contaminants, such as environmental pollutants, producing potentially deleterious and long-lasting mismatches between phenotype and the future environment. We investigated the ability for *in ovo* environmental contaminant exposure to alter the growth trajectory and ovarian function of alligators at five months after hatching. Alligators collected as eggs from polluted Lake Apopka, FL, hatched with smaller body masses but grew faster during the first five months after hatching, as compared to reference-site alligators. Further, ovaries from Lake Apopka alligators displayed lower basal expression levels of inhibin beta A mRNA as well as decreased responsiveness of aromatase and follistatin mRNA expression levels to treatment with follicle stimulating hormone. We posit that these differences predispose these animals to increased risks of disease and reproductive dysfunction at adulthood.

Eckalbar, W.L., Lasku, E., Infante, C.R., Elsey, R.M., Markov, G.J., Allen, A.N., Corneveaux, J.J., Losos, J.B., DeNardo, D.F., Huentelman, M.J., Wilson-Rawls, J., Rawls, A. and Kusumi, K. (2012). Somitogenesis in the anole lizard and alligator reveals evolutionary convergence and divergence in the amniote segmentation clock. Dev. Biol. 363(1): 308-319.

Abstract: The axial skeleton is a defining feature of vertebrates and is patterned during somitogenesis. Cyclically expressed members of the notch and other signaling pathways, described as the 'segmentation clock', regulate the formation of somite boundaries. Comparisons among vertebrate model systems have revealed fundamental shifts in the regulation of expression among critical genes in the notch pathway. However, insights into the evolution of these expression differences have been limited by the lack of information from non-avian reptiles. We analyzed the segmentation clock of the first Lepidosaurian reptile sequenced, the green anole lizard, Anolis carolinensis, for comparison with avian and mammalian models. Using genomic sequence, RNA-Seq transcriptomic data, and in situ hybridization analysis of somite-stage embryos, we carried out comparative analyses of key genes and found that the anole segmentation clock displays features common to both amniote and anamniote vertebrates. Shared features with anamniotes, represented by *Xenopus laevis* and *Danio rerio*, include an absence of lunatic fringe (lfng) expression within the presomitic mesoderm (PSM), a hes6a gradient in the PSM not observed in the chicken or mouse, and EGF repeat structure of the divergent notch ligand, dll3. The anole and mouse share cycling expression of dll1 ligand in the PSM. To gain insight from an Archosaurian reptile, we analysed LFNG and DLL1 expressions in the American alligator. LFNG expression was absent in the alligator PSM, like the anole but unlike the chicken. In contrast, DLL1 expression does not cycle in the PSM of the alligator, similar to the chicken but unlike the anole. Thus, our analysis yields novel insights into features of the segmentation clock that are evolutionarily basal to amniotes versus those that are specific to mammals, Lepidosaurian reptiles, or Archosaurian reptiles.

Azimov, D.A., Filimonova, L.V., Shakabroev, É.B. and Akramova, F.D. (2011). On the identification of the species *Griphobilharzia amoena* Platt, Blair, Purdie *et* Melville, 1991, a parasite of crocodiles in Australia. Parazitologiia 45(3): 245-252. [Article in Russian].

Abstract: The results of the study of typical specimens of the trematode *G. amoena* from blood vessels of the crocodile *Crocodylus johnstoni* in Australia are provided. The data obtained on the morphology of this parasite did not confirm the statement of Platt *et al.* (1991) that this species belongs to the family Schistosomatidae. Morphological data on *G. amoena* enable attributing it to the genus *Vasotrema* of the family Spirorchidae as a new species. In this connection, the monotypical genus *Griphobilharzia* (justified by Platt *et al.*, 1991) becomes a synonym of the genus *Vasotrema*, while the subfamily Griphobilharziinae becomes a synonym of the subfamily Hapalotrematinae.

Viana, L.A., Soares, P., Silva, J.E., Paiva, F. and Coutinho, M.E. (2012). Anurans as paratenic hosts in the transmission of Hepatozoon caimani to caimans *Caiman yacare* and *Caiman latirostris*. Parasitol. Res. 110(2): 883-886.

Abstract: Prevalence of Hepatozoon caimani has been reported in 76% of caimans *Caiman yacare* from the Pantanal region. *Culex* (*Melanoconion*) spp. mosquitoes were recently identified as natural vectors of this parasite. However, culicids

are not typically eaten by crocodilians, suggesting that the main transmission route is through ingestion of insectivorous vertebrates, such as anurans. The susceptibility of wild frogs *Leptodactylus chaquensis*, *Leptodactylus podicipinus* and *Scinax nasicus* to infection by *H. caimani* was verified. Wild-caught anurans were force fed with sporulated oocysts from laboratory-bred *Culex* (*Melanoconion*) mosquitoes. Frogs were killed 30 days postinfection, and their internal organs were fed to caimans *C. yacare* and *Caiman latirostris*. Cystozoites were identified in fresh liver impression smears of *L. chaquensis*. *C. yacare* fed on anuran organ presented gametocytes in peripheral blood circulation between 74 and 80 days postinoculation (dpi). Gametocytes were also verified in *C. latirostris* fed on the internal organs of *L. podicipinus* and *S. nasicus* between 60-70 and 69-75 dpi, respectively. Since frogs used in experiment are sympatric with *C. yacare* and *C. latirostris* and may occur in the diet of these caimans, the results suggest these amphibians are paratenic hosts in the natural transmission cycle of *H. caimani* in Pantanal

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Gardner, M.N., Sterba-Boatwright, B. and Jones, D.R. (2011). Ligation of the left aorta in alligators affects acid-base balance: a role for the R-L shunt. Respir. Physiol. Neurobiol. 178(2): 315-322.

Abstract: This study investigated the effects of preventing bulk flow from the right ventricle to the body via the left aorta (LAo; right to left shunt, R-L) on acid-base status in alligators following feeding, during long-term fasting and a cold temperature exposure. Post-feeding pHv and [Formula: see text] were not significantly different between S and C. Post-feeding pHv increased in both groups of alligators, but not significantly. During fasting, all acid-base variables were similar between the two groups of alligators. A 10°C reduction in environmental temperature resulted in a significant difference in pHv and HCO3- between S and C. Both pHv and HCO3- were significantly higher in C animals. PV(CO2) significantly decreased in both groups during the cold exposure. Preventing the R-L shunt via the LAo had significant effects on acid-base balance in alligators indicating incomplete compensation for its loss and a role for the LAo in metabolic homeostasis

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Wormser, C., Pore, S.A., Elperin, A.B., Silverman, L.N. and Light, D.B. (2011). Potentiation of regulatory volume decrease by a p2-like receptor and arachidonic acid in American alligator erythrocytes. J. Membr. Biol. 242(2): 75-87.

Abstract: This study examined the role of a P2 receptor and arachidonic acid (AA) in regulatory volume decrease (RVD) by American alligator red blood cells (RBCs). Osmotic fragility was determined optically, mean cell volume was measured by electronic sizing, and changes in intracellular Ca(2+) concentration were visualized using fluorescence microscopy. Gadolinium (50 μM), hexokinase (2.5 U/ml), and suramin (100 μM) increased osmotic fragility, blocked volume recovery after hypotonic shock, and prevented a rise in intracellular Ca(2+) that normally occurs during cell swelling. The P2X antagonists PPADS (50 μM) and TNP-ATP (10 μM) also increased fragility and inhibited volume recovery. In contrast, ATPγS (10 μM), α,β-methylene-ATP (50 μM) and Bz-ATP (50 μM) had the opposite effect, whereas 2-methylthio-ATP (50 μM) and UTP (10 μM) had no effect. In addition, the phospholipase A(2) (PLA(2)) inhibitors ONO-RS-082 (10 μM), chlorpromazine (10 μM), and isotetrandrine (10 μM) increased osmotic fragility and blocked volume recovery, whereas AA (10 μM) and its nonhydrolyzable analog eicosatetraynoic acid (ETYA, 10 μM) had the reverse effect. Further, AA (10 μM), but not ATPγS (10 μM), prevented the inhibitory effect of a low Ca(2+)-EGTA Ringer on RVD, whereas both AA (10 μM) and ATPγS (10 μM) caused cell shrinkage under isosmotic conditions. In conclusion, our results are consistent with the presence of a P2-like receptor whose activation stimulated RVD. In addition, AA also was important for volume recovery.

Padilla, S.E., Weber, M. and Jacobson, E.R. (2011). Hematologic and plasma biochemical reference intervals for Morelet's crocodiles (*Crocodylus moreletii*) in the northern wetlands of Campeche, Mexico. J. Wildl. Dis. 47(3): 511-522.

Abstract: Health surveys and hematologic and plasma biochemical analyses were conducted in 52 free-ranging and 51 captive Morelet's crocodiles (*Crocodylus moreletii*) in Campeche, Mexico, March-September 2007. Blood samples from 92 crocodiles (45 free-ranging and 47 captive) were collected for hematologic and plasma biochemical analyses. Average values of erythrocytes of free-ranging crocodiles were 1,046,166 cells/μl, and total white cells were 1.03 × 10(4) cells/μl. Captive crocodiles had erythrocyte and leukocyte values of 1,100,416 cells/μl and 8.51 × 10(3) cells/μl, respectively. There were no significant differences in values of erythrocytes or in hematocrit between free-ranging and captive crocodiles, or between sexes, or among size classes. Counts of leukocytes in free-ranging crocodiles were significantly higher than in captive individuals. The mean values of plasma analytes were 69.55 mg/l (glucose), 250.14 mg/l (cholesterol), 3.04 mg/l (uric acid), 2.70 mg/l (creatinine), and 20.20 IU/l (alanine aminotransferase). There were significant differences in cholesterol between free-ranging and captive crocodiles and between sexes.

Abrahamian, F.M. and Goldstein, E.J. (2011). Microbiology of animal bite wound infections. Clin. Microbiol. Rev. 24(2): 231-246.

Abstract: The microbiology of animal bite wound infections in humans is often polymicrobial, with a broad mixture of aerobic and anaerobic microorganisms. Bacteria recovered from infected bite wounds are most often reflective of the oral flora of the biting animal, which can also be influenced by the microbiome of their ingested prey and other foods. Bacteria may also originate from the victim's own skin or the physical environment at the time of injury. Our review has focused on bite wound infections in humans from dogs, cats, and a

variety of other animals such as monkeys, bears, pigs, ferrets, horses, sheep, Tasmanian devils, snakes, Komodo dragons, monitor lizards, iguanas, alligators/crocodiles, rats, guinea pigs, hamsters, prairie dogs, swans, and sharks. The medical literature in this area has been made up mostly of small case series or case reports. Very few studies have been systematic and are often limited to dog or cat bite injuries. Limitations of studies include a lack of established or inconsistent criteria for an infected wound and a failure to utilize optimal techniques in pathogen isolation, especially for anaerobic organisms. There is also a lack of an understanding of the pathogenic significance of all cultured organisms. Gathering information and conducting research in a more systematic and methodical fashion through an organized research network, including zoos, veterinary practices, and rural clinics and hospitals, are needed to better define the microbiology of animal bite wound infections in humans.

Nóbrega Alves, R.R., Silva Vieira, W.L., Gomes Santana, G., Silva Vieira, K. and Guedes Pereira Montenegro, P.F. (2013). Herpetofauna used in traditional folk medicine: conservation implications. Animals in Traditional Folk Medicine 2013: 109-133.

Abstract: This chapter provides an overview of the global use of herpetofauna in traditional folk medicine and the implications for conservation. The results indicate that 331 species (284 reptiles and 47 amphibians) are used in traditional folk medicine around the world. Among the species recorded, 182 reptiles and 42 amphibians are listed in the IUCN Red List. Additionally, 93 reptiles are in some of the appendices of CITES. These numbers demonstrate the importance of understanding such medicinal uses in the context of reptile conservation as well as the need for considering sociocultural factors when establishing management plans directed toward the sustainable use of these reptiles.

Wallace, K., Leslie, A. and Coulson, T. (2012). Re-evaluating the effect of harvesting regimes on Nile crocodiles using an integral projection model. Journal of Animal Ecology (doi: 10.1111/j.1365-2656.2012.02027.x).

Abstract: Crocodile populations are size-structured, and for populations that are subject to harvesting, removal is typically size selective. For this reason, size-structured matrix models are typically used to analyse the dynamics of crocodile populations. The boundaries between the size classes used to classify individuals in these models are typically chosen arbitrarily. This is problematic because results can depend upon the number and width of size classes. The recent development of continuous character population models termed integral projection models (IPM) has removed the need to arbitrarily classify individuals. These models are yet to be applied to harvested animal populations. Using information obtained from the literature, we develop an IPM for crocodiles. We use perturbation analyses to investigate how altering size-specific demographic rates influences the population growth rate and the strength of selection on snout to vent length. We find that perturbations can lead to complex responses. Sensitivity analysis to population growth and fertility selection reveals that the smallest animals and the sizes of early breeding individuals and their eggs may have more influence on these population biology parameters than previously thought. Although our model is relatively simple, our results show that IPM can be used to gain theoretical insight into the possible consequences of altering size-specific demographic rates on the population and evolutionary ecology of harvested populations.

Austin, B.J. and Corey, B. (2012). Factors contributing to the longevity of the commercial use of crocodiles by Indigenous people in remote Northern Australia: a case study. The Rangeland Journal 34: 239-248.

Abstract: Access to land and resources has not, in itself, been sufficient for improving the wellbeing of Indigenous people living in remote regions of Australia. Much of the land has limited potential for mainstream market-based economic development. However, some Indigenous Australians have been able to use wildlife commercially to realise economic opportunities and to enhance their capacity to engage in natural resource management on their land. In this paper, a case study is presented of one such enterprise which has managed a crocodile egg-harvesting operation from a remote township for almost 15 years. Using a sustainable livelihoods approach to conduct field observations and semi-structured interviews, key factors were identified that had contributed to the longevity of this operation. These were minimal anti-use sentiment, demonstrably sustainable harvests, the market, the institutional context, parent-organisation support, activating and enhancing capitals and capabilities, and locally relevant enterprise activity. The crocodile egg-harvesting activity investigated is an example of a community-governed natural resource-based enterprise that has been able to engage Indigenous people in market-based economic activity in remote northern Australia. The findings have potential value to Indigenous peoples and communities, development practitioners, policy-makers and natural resource managers interested in the sustainable use of wildlife and Indigenous economic

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Franke, F.A., Schmidt, F., Borgwardt, C., Bernhard, D., Bleidorn, C., Engelmann, W-E. and Schlegel, M. (2012). Genetic differentiation of the African dwarf crocodile *Osteolaemus tetraspis* Cope, 1861 (Crocodylia: Crocodylidae) and consequences for European zoos. Organisms Diversity & Evolution (doi: 10.1007/s13127-012-0107-1).

Abstract: The endangered African dwarf crocodile *Osteolaemus tetraspis* is distributed in Central and Western Africa. Conventionally, two subspecies were distinguished: *Osteolaemus tetraspis tetraspis* and *Osteolaemus tetraspis osborni*. The taxonomic significance of diagnostic morphological characters is still being discussed and the existence of additional species in the *Osteolaemus* group remains unclear. Recent molecular studies suggest the

existence of three allopatric species in the genus *Osteolaemus*. These results supported a division of the dwarf crocodile into a Congo Basin form (*O. osborni*), an Ogooué Basin form (*O. tetraspis*), and a third separate evolutionary lineage from Western Africa. Several European zoos host African dwarf crocodiles. For reasons of conservation and possible reintroduction, it is important to clarify provenance of these zoo animals. Therefore, we conducted molecular and phylogenetic analyses of three mitochondrial and two nuclear gene sequences with all available samples from European zoos and museums. We also estimated the origin of the zoo animals by comparing sequences of wild animals and museum samples of known provenance. Our study strongly supports three distinct lineages of *Osteolaemus* as recently postulated, but also reveals a fourth evolutionary lineage. We demonstrate that, of the European zoo animals sampled, only one dwarf crocodile corresponds to the Congo Basin form (*O. osborni*) whereas the majority of individuals correspond to the three other forms. Four zoo animals belong to the new fourth group; but their provenance is still unresolved. The origin of these animals is probably located in an African region from which no wild animal samples are currently available. Further investigations and sampling of other regions should be completed to clarify the identity of this fourth lineage. We found potential hybrids from European zoological gardens using nuclear DNA sequences. The European Studbook will use these results for further breeding programmes to keep genetically suitable *ex-situ* populations as reassurance colonies for prospective reintroduction into African countries.

Raske, M., Lewbart, G.A., Dombrowski, D.S., Hale, P., Correa, M. and Christian, L.S. (2012). Body temperatures of selected amphibian and reptle species. Journal of Zoo and Wildlife Medicine 43(3): 517-521.

Abstract: Ectothermic vertebrates are a diverse group of animals that rely on external sources to maintain a preferred body temperature. Amphibians and reptiles have a preferred optimal temperature zone that allows for optimal biological function. Physiologic processes in ectotherms are influenced by temperature; these animals have capabilities in which they make use of behavioral and physiologic mechanisms to thermoregulate. Core body, ambient air, body surface, and surface/water temperatures were obtained from six ectothermic species including one anuran, two snakes, two turtles, and one alligator. Clinically significant differences between core body temperature and ambient temperature were noted in the black rat snake, corn snake, and eastern box turtle. No significant differences were found between core body and ambient temperature for the American alligator, bullfrog, mata mata turtle, dead spotted turtle, or dead mole king snake. This study indicates some ectotherms are able to regulate their body temperatures independent of their environment. Body temperature of ectotherms is an important component that clinicians should consider when selecting and providing therapeutic care. Investigation of basic physiologic parameters (heart rate, respiratory rate, and body temperature) from a diverse population of healthy ectothermic vertebrates may provide baseline data for a systematic health care approach.

Mauger, L.A., Velez, E., Cherkiss, M.S., Brien, M.L., Boston, M., Mazzotti, F.J. and Spotila, J.R. (2012). Population assessment of the American crocodile, *Crocodylus acutus* (Crocodilia: Crocodylidae) on the Pacific coast of Costa Rica. Rev. Biol. Trop. 60(4): 1889-1901.

Abstract: The American crocodile, *Crocodylus acutus*, is widely distributed in the American neotropics. It is endangered throughout most of its range and is listed as vulnerable by the International Union for the Conservation of Nature (IUCN) and on Appendix I of the Convention for the International Trade in Endangered Species of Wild Flora and Fauna (CITES). Despite this listing, there are few published reports on population status throughout most of its range. We investigated the status of the *C. acutus*, at several locations along the Pacific coast of Costa Rica. We carried out spotlight and nesting surveys from 2007-2009 along the Costa Rican Pacific coast in four distinct areas, coastal areas of Las Baulas (N= 40) and Santa Rosa (N= 9) National Parks and the Osa Conservation Area (N= 13), and upriver in Palo Verde National Park (N= 11). We recorded crocodile locations and standard environmental data at each observation. Encounter rates, population structure, distribution within each area and data on successful nesting (presence of hatchlings, nests, etc.) were determined. We attempted to capture all crocodiles to record standard morphometrics. A total of 586 crocodiles were observed along 185.8 km of survey route. The majority of animals encountered (54.9%) were either hatchlings (<0.5 m) or juveniles (0.5-1.25 m). The average non-hatchling encounter rate per survey for the Pacific coast was 3.1 crocodiles/km, with individual encounter rates ranging from 1.2 crocodiles/km to 4.3 crocodiles/km in Las Baulas National Park and the Osa Conservation Area respectively. Distribution of size classes within the individual locations did not differ with the exception of Santa Rosa and Las Baulas National Parks, where hatchlings were found in water with lower salinities. These were the first systematic surveys in several of the areas studied and additional work is needed to further characterize the American crocodile population in Costa Rica.

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