CROCODILE

SPECIALIST

GROUP

NEWSLETTER

VOLUME 35 No. 4 • OCTOBER 2016 - DECEMBER 2016

IUCN • Species Survival Commission

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COVER PHOTOGRAPH: Captive Orinico crocodile (*Crocodylus intermedius*) in Hato Masaguaral, Guarico State, Venezuela. Photograph: Alvaro Velasco.

CSG Newsletter Subscription

The CSG Newsletter is produced and distributed by the Crocodile Specialist Group of the Species Survival Commission (SSC) of the IUCN (International Union for Conservation of Nature).

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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We thank all patrons who have donated to the CSG and its conservation program over many years, and especially to donors in 2015-2016 (listed below).

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Editorial

The IUCN Species Survival Commission (SSC) will shortly send out a mass mailing to all current CSG members, and invite them to renew their CSG membership. If you wish to maintain your membership to the CSG it is imperative that you respond directly to this request. Failure to do so will result in your membership not being renewed.

The Proceedings of the 24th CSG Working Meeting (South Africa, May 2016) are now available in electronic (pdf) format on the CSG website. Enormous thanks are due to Charlie Manolis for compiling them in a standardised layout and applying his editorial skills as needed.

Around 150 participants attended "Christmas CrocFest 2016" on 3 December 2016 at Shawn Heflick's home in Palm Bay, Florida. The event raised over $US33,000, with the primary beneficiary being the Orinoco crocodile (*Crocodylus intermedius*) project in Venezuela. The "Ralf Sommerlad Crocodile Conservation Award" was awarded to Peter Brazaitis, who attended the CrocFest with his wife, Myrna Watanabe. A more detailed report will be posted on the CSG website as soon as it is available.

The CSG has been approached by the Government of the State of Queensland, Australia, to review its Crocodile Monitoring Program for *Crocodylus porosus*, which is implemented through its Department of Environment and Heritage Protection. Selected CSG members will assist with the review, which is due for completion by the end of January 2017.

Status Survey and Conservation Action Plans will be updated through 2017, and regional chairs and authors will be contacted in early 2017 in order to begin this process. The Action Plans are an important source of information and guide conservation efforts for many crocodilian species.

A crocodile symposium will be organised within the framework of the XI Latin American Congress of Herpetology, to be held on 24-28 July 2017 in Quito, Ecuador. Alvaro Velasco, Sergio Balaguera-Reina and Pablo Siroski will organise the crocodile symposium, and they have already contacted a number of CSG members regarding their participation in the symposium and possible presentations.

A conference on Crocodilian Genetics, Morphology and Molecular Sciences will be held at Lake Charles, Louisiana, USA, 8-11 August 2017. Details will be available shortly.

The 25th CSG Working Meeting will be held in Santa Fe, Argentina, in May 2018. Details will be posted as soon as they become available.

Professor Grahame Webb, *CSG Chair.*

"The Croc Alert"

The CSG was contacted in late 2016, seeking input into a project undertaken by a 6th grade team from Oakhill Elementary School (Oakhill, Virginia, USA) as part of the First Lego League Challenge (this year's theme was "Animal Allies"). "Teams of kids ages 9 to 14 are challenged to design their own solution to current scientific problems, then build LEGO® robots that perform autonomous "missions." In the process, they develop valuable life skills and discover exciting career possibilities in science and technology. They even discover that they, too, can make positive contributions to society" (www.firstinspires.org/node/3461).

Thanks are extended to Steve Gorzula, who was able to visit the school on 13 November 2016 to chat with the team (Fig. 1) and provided them with a letter of support, including feedback, on their project - a croc warning device ("Croc Alert").

Figure 1. Lego Cookies Team from Oakhill Elementary School; from left, Michaela Bravo, Anushka Chivaluri, Kimberly Howard, Usha Rahim, Zoe Rosas, Niyathi Vadlapatla, Nitya Varigala, Anjini Verdia and Leana Wang.

A description of the device and the project, provided by the team, is below:

Croc Alert

The Croc Alert is a device that senses and alarms people when a crocodile is nearby.

How it works

Crocodiles make different sounds in different situations such as threat calls, distress call, etc. Croc Alert detects those sounds through sound sensors. It also detects slight movements of the crocodiles around it through cameras. The technology in the device processes the sounds detected, animal movements and matches with crocodile sounds and features. It sets off the alarm to alert people if the sound or features match.

Features

Has infrared cameras in the front and back of the device. Cameras captures the crocodiles movements, features. The technology in the device processes the sounds detected, the crocodiles shapes. It alerts people using an alarm

Crocodiles Device technology processes the sounds detected and It alerts using alarms and sense the crocodile features. The Croc Alert, mainly works by capturing sounds through sound receivers in the device that detect all sounds made by the crocodile. Along with the device, there is also an app. This app is what tells you that there is a crocodile present. Once the Croc Alert detects a crocodile, the speakers set off an alarm that signals anyone nearby that there is a crocodile present so they can know to call animal control. If needed, the Croc Alert also has two cameras on the front and back to confirm that it is a crocodile. To make it blend in the background , we put the device in a hollow plastic rock, so you can take it wherever you want as well.

Features

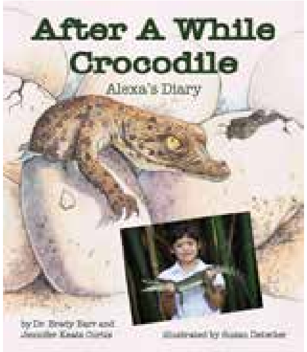
The Croc Alert is in the shape of a large rock, it's designed like this to blend in with its surroundings. The sound sensors are spread out around the device, and the speaker that sounds the alarm is right in the center of the device. The device is also portable, so you . can move it around to different places. The Croc Alert runs on battery power in the night and solar power using photovoltaic cells (cells that directly convert solar power into energy) in the morning.

CSG Student Research Assistance Scheme

The Student Research Assistance Scheme (SRAS) provided funding to 4 student in 2016, and three (3) applications are currently under review.

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

Books

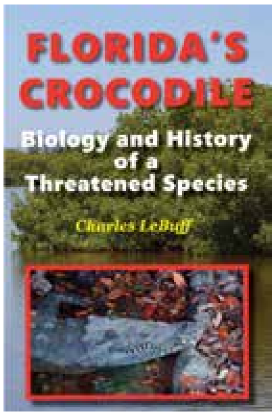


In Costa Rica, some schoolchildren have the opportunity to raise baby crocodiles for a brief time during a unique headstart program. Dr. Brady Barr and author Jennifer Keats Curtis introduce children to this fascinating topic with their new picture book "After A While Crocodile: Alexa's Diary" (Arbordale Publishing). The journal-style story is written from the perspective of Alexa, a Costa Rican girl participating in the program. She journals the growth of her crocodile, "Jefe", and along the way, learns a lot about these reptiles, and why it is important to help conserve them.

Vivid photographs are combined with Susan Detwiler's illustrations to help young readers grasp the concept that this is a realistic fictional story about a real program. The partnership between Brady Barr and Jennifer Keats Curtis helps children understand more about crocodiles and the critical need for their conservation.

"After A While Crocodile" will be available in hardcover, paperback, ebook, and Spanish editions. See the homepage of the CSG website (www.iucncsg.org) for additional details.

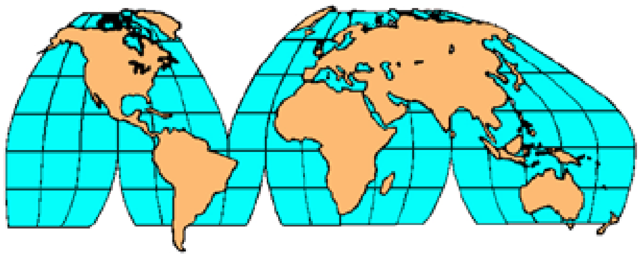
"Florida's Crocodile: Biology and History of a Threatened Species" (Amber Publishing), written by Charles LeBuff, is his third contribution to the herpetology of Florida in book form. With a focus on the American crocodile (*Crocodylus acutus*), the book is a comprehensive examination of the species' biology and life history (eg growth, senses, salt-tolerance, reproduction, prey, longevity, size, temperature tolerance), and interaction with humans in Florida.



The text is interspersed with interesting anecdotes about *C. acutus* and its more abundant relative, *Alligator mississippiensis*.

The century-long decline and recent ongoing recovery of the species at its northern-most range is documented, in easy to read text. Details on pricing, etc., will be available on the homepage of the CSG website (www.iucncsg.org) for a short period.

Regional Reports



East and Southern Africa

Botswana

POPULATION TRENDS IN A PREVIOUSLY EXPLOITED NILE CROCODILE POPULATION IN THE OKAVANGO PANHANDLE, BOTSWANA. The panhandle region of the Okavango Delta, Botswana, has been the location of significant historical population declines of the Nile crocodile (*Crocodylus niloticus*) population. These declines were as a result of the commercial utilisation of crocodiles for skins, which saw as many as 48,000 crocodiles removed between 1957 and 1968 (Pooley 1982). Commercial ranching was introduced in 1983 as a way of sustainably meeting the international demand for skins. This led to the removal of 1050 live adults and the collection of 14,000 eggs from the Okavango between 1983 and 1988 (Simbotwe 1988).

The population density comparative study will allow us to understand the success (or failures) of previous conservation and management regulations. This will allow officials to remedy any shortfalls in regulation and policy around the management of this keystone species. As a recently listed UNESCO World Heritage Site (UNESCO 2014), the Government is required to closely monitor wildlife species numbers and this study will provide some of the most comprehensive population monitoring data for any wildlife species in the Okavango. As our efforts are focused in unprotected areas of the Okavango, this study serves as a critical assessment of the wildlife and human co-existence challenges.

The spotlight survey was conducted on 23-29 August 2016, from Etsatsa Island, approximately 5 km downstream from Seronga Village in the south, to Shakawe Village near the Botswana-Namibia border in the north. Pre-determined transects, selected for accessibility (some channels, such as the Kgala-Thoaga channel, were completely blocked by *Papyrus*) and a minimum width of 30 m were travelled between 1930 and 0200 h. The observers consisted of Vince Shacks, Prof. Lee Fitzgerald and Dr. Sven Bourquin. Observers were changed every hour to reduce the effects of fatigue. SB and VS have been members of the research team since 2003, and both were involved in the initial spotlight survey in 2008.

Crocodiles were detected by means of a 1.5 million candlepower spotlight that illuminated the main water column and the water/vegetation ecotone. Crocodiles sighted were assigned to classes based on total length (TL), estimated by the trained observers by multiplying the head-length by 7 to estimate TL. Size-classes were: hatchlings (<34 cm); yearlings (34<78 cm); juveniles (78<130 cm); sub-adults (130<230 cm); and, adults (≥230 cm). Crocodiles that submerged before the observer was able to estimate a size were recorded as "Eyes Only".

The panhandle was divided into 5 survey zones (Fig. 1): A - Seronga to the lower entrance of the Phillipa channel; B - main channel between the lower and upper Phillipa entrances; C - Phillipa channel, excluding the upper Phillipa; D - main channel between the upper Phillipa entrance and Redcliffs; and, E - main channel between Redcliffs and Shakawe, excluding the blocked Kgala-Taoga lagoons and upper channel.

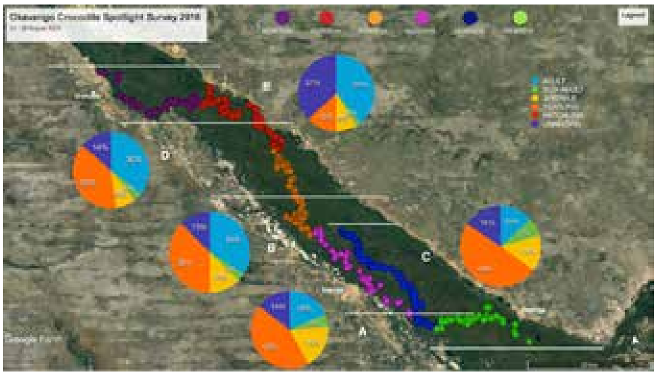


Figure 1. Results of 2016 spotlight surveys. Size class composition is shown for each survey section (A-E; see text).

A total distance of 265 km was covered over 6 nights of surveys, and a total of 433 crocodiles was observed (1.63 crocodiles/km), of which 71 (16.4%) were Eyes Only. The remaining 362 crocodiles ranged in size from 35 to 500 cm TL. Of these, 167 (46.1%) were yearlings, 53 (14.6%) were juveniles, 19 (5.2%) were sub-adults and 123 (34.0%) were adults. A correction factor of 4.46 (Bourquin 2008) was used to estimate total population size, resulting in a total population estimate, excluding the panhandle north of Shakawe, the upper Phillipa channel and the Kgala-Thaoga lagoons, of 1931 crocodiles.

The spotlight surveys are used to analyse whether the population trend is either increasing or decreasing over time. The total numbers calculated from pure spotlight surveys do not necessarily represent an accurate population estimate but rather provide a baseline population number to monitor trends. Based on the first monitoring spotlight survey (2008), this baseline figure is 1793 non-hatchling crocodiles (Table 1).

The population estimate of 1931 crocodiles in 2016 represents a 7.7% increase over the 2008 estimate. Notwithstanding that only two years of data are available at this time, the results suggest an average rate of increase of 0.9% per annum since 2008.

Table 1. Spotlight counts (N), size class composition (%) and population estimates based on spotlight surveys in 2008 and 2016. RD= relative density (ind./km).

Size Class	---- 2008 ---- N	%	---- 2016 ---- N	%
Hatchlings	0	0.0	0	0.0
Yearlings	93	27.6	167	46.1
Juveniles	53	15.7	53	14.6
Sub-adults	72	21.4	19	5.2
Adults	119	35.3	123	34.0
Eyes Only	65	-	71	-
Totals Sighted	402	100.0	433	100.0
RD - low water	1.52	-	1.63	-
Est. Population	**1793**	**-**	**1931**	**-**

The proportion of crocodiles in each size class has remained somewhat constant over time. One notable exception is the decline in the proportion of sub-adults in 2016 (a "decline" of 74% relative to 2008; Table 1). The reasons for this are unclear. Conditions between the two surveys were fairly constant with regard to: timing (21 August-19 September); observers [two of the three researchers (VS, SB) were on each survey]; survey methodology; survey sectors (exact same transects); water levels (difference between surveys estimated to be less than 10 cm), etc.

No hatchlings were observed in either of the two surveys and this is put down to the timing of the survey and the fact that hatchlings, which hatch predominantly in December-January in the Okavango, would already have increased in length to place them into the "yearling" category (34<78 cm TL).

The overall increase in the estimated population is encouraging. While the increase is not substantial, it is certainly a strong enough indication that the population is at the very least stabilizing and possibly showing signs of increasing. The possible decline in the sub-adult portion of the population is of some concern, and merits further investigation.

This size class has been shown to be heavily reliant on fish in its diet (Wallace and Leslie 2008). Casual observations made during the spotlight surveys suggest a decline in both fish numbers and diversity in the lagoon systems. This anecdotal evidence may support a theory that the decline in sub-adults encountered on the 2016 survey could be related to dwindling fish numbers in these lagoon habitats.

Commercial fishing activities along the Okavango Panhandle are heavily focused on lagoon systems where nylon monofilament gillnets are placed adjacent to the lagoon edges to capture and trap the fish species within this habitat type. Sub-adult crocodiles target the same species of fish in these lagoon systems and this fact is likely to bring fisherman and sub-adult crocodiles into conflict. Further anecdotal reports from recreational fishermen, lodges and residents in the region support the notion that fish catch rates have decreased substantially. Reports of large-scale commercial fishing for export markets has been suggested as the reason for this.

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South Asia and Iran

India

NOTE ON GHARIAL REINTRODUCTION AND RESCUE IN UPPER GANGA RIVER. WWF-India has been involved in the Gharial Recovery Programme since the National Chambal Wildlife Sanctuary Gharial crisis in December 2007 (Yadav *et al.* 2013). In collaboration with the Uttar Pradesh Forest Department (UPFD) WWF-India started a Gharial reintroduction program at Hastinapur Wildlife Sanctuary. This first of its kind , it focused on re-establishing the breeding population of Gharial in its historic distribution in the River Ganga. Sightings of large Gharial (about 3 m) are common in the river, which indicates that things are on the right track, and nesting is expected in 2-3 years. Since January 2009, 606 captive-reared Gharial from Kukrail Rehabilitation Centre (Lucknow) have been released into River Ganga. In collaboration with University of Tokyo (Japan), WWF-

India has initiated a study on Gharial Bio-logging Science to understand the underwater behaviour and surrounding habitat of a free ranging Gharial (Nawab *et al.* 2013). WWF-India works in coordination with local communities to elicit support for biodiversity conservation in River Ganga.

Nine (9) animals released in 2014 were tagged last year to monitor their habitat dispersal patterns and regular monitoring is currently being conducted through radio-tracking. WWF-India and UPFD will initiate 20 days of tracking of these animals to closely watch their acclimatization in the wild.

A few reintroduced Gharial also wandered far downstream and were "rescued" by the WWF-India team on several occasions. One such example is a sub-adult female Gharial that was rescued from Lower Ganga Canal on 16 October 2016. She have been moving around the gates of the Narora Barrage and accidentally got into the Lower Ganga Canal. When the gates were closed for cleaning the canal, water levels dropped and the animal got trapped, where she was found (Fig. 1).

Figure 1. Trapped Gharial at Ganga Canal, Narora.

The first author received a telephone call from the local riparian community at around 0730 h on 15 October 2016, informing that a Gharial was trapped in Ganga Canal at Narora (28°11'24.9"N; 78°23'41.3"E). He informed Director-River Basin & Water Policy, WWF-India, and approached the Chief Conservator of Forests (Meerut, UPFD) to discuss the plan of action. Based on this, UPFD requested WWF-India to lead the rescue operations along with UPFD staff.

On the morning of 16 October 2016 the rescue team reached the site (at Narora) and arrangements were made. Before capture, the rescue team assessed the size of the Gharial and got a wooden crate (Fig. 2) made by a local carpenter. Then at 1730 h the process of capturing the stranded Gharial began, taking 2 hours to move the animal out from the mud. The rescue team decided to release the rescued Gharial in the nearby protected area of Hastinapur Wildlife Sanctuary, as the site is safe and far upstream of the stranding site (Fig. 3).

The objective of WWF-India's Gharial reintroduction program is to establish breeding populations in the Ganga, therefore proper rescuing and rehabilitation of stranded animals is very important. The rescued female Gharial was 3.2 m total length and weighed 86 kg, suggesting that she was close to maturity. During overnight transport from Narora to Hastinapur Wildlife Sanctuary water was poured every 2-3 hours onto the Gharial through a hole in the box to avoid dehydration. To avoid shocks and injury to the animal, the crate was safely secured with a padding of cotton mattresses.

Figure 2. Gharial being released at Makhdumpur Ghat.

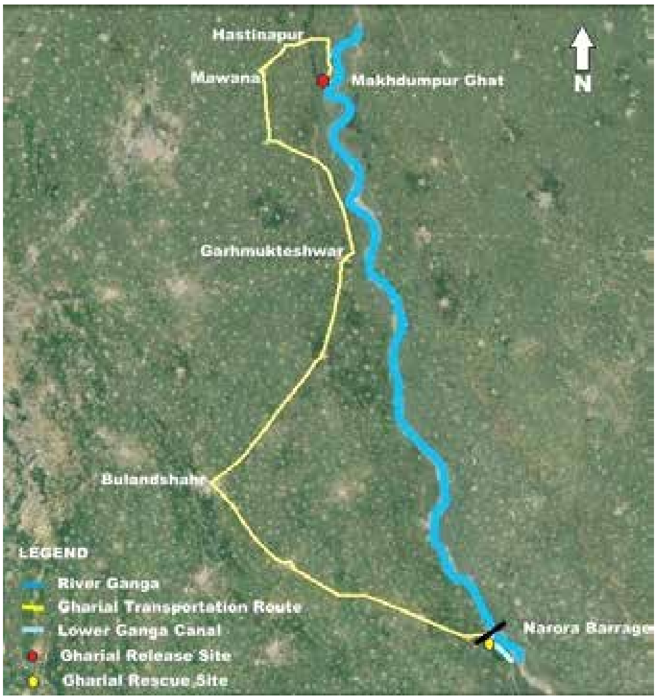

Figure 3. Location of capture and release sites.

The Gharial was released at Makhdumpur Ghat (29°05'28.6"N; 78°03'50.2"E) at around 0730 h on 17 October 2016. The whole operation took 14 hours. The animal appeared to be in good condition and was active throughout the operation. We are continuously monitoring her behaviour since release.

At 1035 h on 22 October 2016 the Gharial was spotted near Dudhli Khandar village (29°08'22.5"N, 78°03'40.7"E), about 5.5 km upstream of the release site. She seemed to be in good physical shape and was basking on a small partially submerged muddy island in the middle of the river. She basked for 18 minutes (1035-1053 h) in the sun-facing direction, before moving into the water. She did not appear at this location until 1300 h. We visited the same location in the evening (1530-1700 h), but the animal was not sighted.

Released Gharial are surviving and flourishing in the upper River Ganga, growing an average of 35 cm/year and 10 kg/year (Yadav *et al*. 2013).

Acknowledgements

The rescue was conducted as a part of the Gharial Reintroduction program of WWF-India. We are indebted to the Uttar Pradesh Forest Department for granting permissions. We express our sincere gratitude to Mr. Ravi Singh (SG & CEO, WWF-India) for his continuous support and encouragement. We are very thankful to Mr. Mukesh Kumar (Chief Conservator Forest-Meerut) and Mr. Suresh Babu for their swift coordination. The author also thanks Prof. B.C. Chaudhary for his guidance (on the telephone) during the rescue operation. We appreciate the efforts and sincere participation of Mr. Raju (WWF-India) and Mr. Seetu (WWF-India) during the operation.

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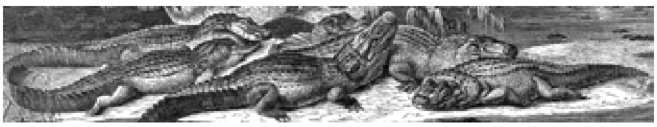
Science



Recent Publications

Da Silva Braga, V.H., Armelin, V.A., Teixeira, M.T., Abe, A.S., Rantin, F.T. and Florindo, L.H. (2016). The effects of feeding on cardiac control of the Broad-nosed caiman (*Caiman latirostris*): The role of the autonomic nervous system and NANC factors. Journal of Experimental Zoology (doi: 10.1002/jez.2036).

Abstract: The metabolic increment that occurs after feeding demands cardiovascular adjustments to be maintained, as increased heart rate (*f*H) and cardiac output. In mammals, postprandial tachycardia seems to be triggered by an increase in adrenergic activity and by nonadrenergic noncholinergic (NANC) factors, while in ectothermic vertebrates, this adjustment seems to be linked to a withdrawal of vagal drive as well as to NANC factors. Because the factors behind postprandial tachycardia have not yet been investigated in crocodilians, the present study sought to evaluate the postprandial tachycardia mediators in the broad-nosed caiman. To this end, fasting and digesting animals were instrumented with intraperitoneal cannula and subcutaneous electrocardiogram electrodes (for the measurement of *f*H, cardiac autonomic tones, and total *f*H variability, as well as for a power spectral analysis of *f*H). Data were then collected with the animals in an untreated state, as well as after muscarinic cholinergic blockade with atropine (2.5 mg kg^{-1}) and after double autonomic blockade with atropine and propranolol (5.0 mg kg^{-1}). Fasting animals' *f*H was ~18 bpm, a value which increased to ~30 bpm during digestion. After the double autonomic blockade, fasting animals exhibited an *f*H of ~15 bpm, while digesting animals' *f*H was ~23 bpm. This result is evidence of the presence of NANC factors with positive chronotropic effects acting during digestion. The calculated autonomic tones showed that, after feeding, the adrenergic tone increased while the cholinergic tone remained unchanged. Finally, fH variability analyses revealed that this adrenergic increase is primarily derived from circulating catecholamines.

Pooley, S. (2016). A cultural herpetology of Nile crocodiles in Africa. Conservation and Society 14(4): 391-405.

Abstract: Human-wildlife conflict is a growing problem worldwide wherever humans share landscapes with large predators, and negative encounters with eight species of the crocodilians is particularly widespread. Conservationists' responses to these adverse encounters have focused on the ecological and behavioural aspects of predators, rather than on the social, political, and cultural contexts, which have threatened their existence in the first place. Few studies have thus far tried to understand the rich, varied, contradictory, and complex relations that exist between particular humans and human societies, and particular predators and groups of predators. It is in the spirit of Brian Morris's explorations of the interactional encounters and co-produced sociabilities that exist between humans and animals in specific places and regions that this paper offers a cultural herpetology (an account of human-crocodile interrelations) of the Nile crocodile (*Crocodylus niloticus* and *C. suchus*) in Africa. It draws on extensive historical documentation of the interactions of humans and crocodiles across Africa to examine how diverse and complex human responses to Nile crocodiles have been, and continue to be, and suggests some implications for improving human-crocodile relations.

Njau, J. and Gilbert, H. (2016). Standardizing terms for crocodile-induced bite marks on bone surfaces in light of the frequent bone modification equifinality found to result from crocodile feeding behavior, stone tool modification, and trampling. 2016 FOROST Occasional Publications No. 3.

Young, B.A. (2016). Anatomical influences on internally coupled ears in reptiles. Biological Cybernetics (doi:10.1007/s00422-016-0699-1).

Abstract: Many reptiles, and other vertebrates, have internally coupled ears in which a patent anatomical connection allows pressure waves generated by the displacement of one tympanic membrane to propagate (internally) through the head and, ultimately, influence the displacement of the contralateral tympanic membrane. The pattern of tympanic displacement caused by this internal coupling can give rise to novel sensory cues. The auditory mechanics of reptiles exhibit more anatomical variation than in any other vertebrate group. This variation includes structural features such as diverticula and septa,

as well as coverings of the tympanic membrane. Many of these anatomical features would likely influence the functional significance of the internal coupling between the tympanic membranes. Several of the anatomical components of the reptilian internally coupled ear are under active motor control, suggesting that in some reptiles the auditory system may be more dynamic than previously recognized.

Soler, J.A., Dudin, Capilla, B.R. and Harrison, M.E. (2016). Surveys of *Tomistoma schlegelii* in the Sabangau River, Central Kalimantan, Indonesia. Borneo Nature Foundation: Palangka Raya, Indonesia.

Abstract: *Tomistoma schlegelii* is a highly secretive crocodilian species predominantly associated with peat swamp forest in Southeast Asia. The IUCN estimates that the tomistoma population may have been reduced almost 30% in the past 75 years due to continuing loss and fragmentation of swamp forest, leading to its classification as "vulnerable". Despite this, our knowledge on *T. schlegelii* and other crocodilians in Central Kalimantan is extremely poor and no surveys have been performed in the province's largest wetland area: the Sabangau peat-swamp forest. In light of this, the Borneo Nature Fundation (BNF) conducted nocturnal and diurnal river surveys, and collected habitat information along the Sabangau River and tributaries. Combined with questionnaire data from local villages, this provided the first information on distribution, perceived population trends and threats for these crocodilians. This information is a vital prerequisite for identifying threats and opportunities for conservation of *T. schlegelii* and other crocodilians in the region. The Sabangau River is 180 km long and represents a unique wetland black-water ecosystem. To assess *T. schlegelii* presence in the Sabangau River, several expeditions were organized along the river to survey different areas. Using a traditional boat (klotok) with no engine the surveys were conducted at different times of the day (morning, midday and night). A total 50 structured interviews were also conducted in the river's main villages and settlements. A total of 62 conducted spotlight surveys were performed over 14 months, covering a total of 100 km of river. One direct observation of *T. schlegelii* was recorded during these surveys, confirming its presence in Sabangau. A number of other important fauna species were also sighted during the surveys. The structured interviews indicated that two species of crocodiles are present in the Sabangau River: Tomistoma and the estuarine crocodile (*Crocodylus porosus*). Forty-five percent of interviewees reported seeing *T. schlegelii* in the Sabangau River at least once. According to the interviews, the most likely location to find *T. schlegelii* in Sabangau is in the area between Bangah and Paduran villages (80% of people interviewed in Bangah and surroundings reported having seen a Tomistoma). A total 14% of interviewees thought that there had been no commercial use/exploitation of crocodiles in the last 50 years andthere was no reported social perception of crocodiles being dangerous. People generally do not therefore kill them, though it is uncertain whether the low rate of killing reported may represent a serious threat to the area's population. Respondents varied in their perceptions of Tomistoma population trends in the area, with 76% reporting that they did not know or not responding. Despite this, some distinct threats were identified as having a potential impact on the *T. schlegelii* population in Sabangau. Most important among these are recurrent forest fires, land/forest conversion (potential habitat loss), fish over-harvesting and waterway disturbance and pollution. Conservation efforts for *T. schlegelii* should therefore be directed towards protecting the whole ecosystem - including the forest, rivers and fish populations - to ensure long-term population persistence in the area. A detailed list of conservation recommendations for Tomistoma in the area is presented.

Simoncini, M.S., Parachú Marcó, M.V., Gonçalves Portelinha, T.C. and Piña, C.I. (2016). Evaluation of factors associated with predation on *Caiman latirostris* nests (Crocodylia: Alligatoridae) in Argentina. Phyllomedusa 15(2): 137-146.

Abstract: Predation is a major cause of crocodilian egg loss. However, at present, the mechanisms by which predators detect nests is unknown. Previous studies have reported that predators are able to detect prey using both visual and olfactory cues. This study aims to determine the natural predation rate on Broad-snouted caiman (*Caiman latirostris*) in a normal "year" (ie no extreme climatic events) and whether olfactory or visual cues attract predators to caiman nests, and to evaluate the effect of maternal presence on nest predation. In December 2010, we searched for nests in the north of Santa Fe Province, Argentina. Each nest was assigned to one of the following treatments: (1) control nests (nests were observed from a distance to avoid disturbance), (2) visual attraction nests (yellow flagging tapes were tied to vegetation around the nest, (3) olfactory attraction nests (nests were opened, one egg from the clutch was broken, and then the nests were covered again), (4) olfactory attraction from human disturbance (material was manipulated by researchers). The natural predation rate on broad-snouted caiman nests was found to be 21% during the nesting season. Both olfactory and visual cues were associated with increased predation rates, and human disturbance was strongly associated with increased nest predation at terrestrial sites. Predation rates were less at nests attended by female caiman. Management programs that harvest eggs in wild populations (ranching) are predicated on the assumption that removal of some eggs is sustainable, because some will be lost to natural causes (eg predation and flooding) and the remaining hatchlings will have improved survival rates. To reduce nest predation of Broad-snouted caiman between the time when the nest is found and whed. by en the eggs are collected, we propose to avoid identification of nest sites with highly visible markings (eg flagging tapes tied to vegetation around nests) and to collect eggs immediately after they are found.

Nifong, J. C. 2016. Living on the edge: trophic ecology of *Alligator mississippiensis* (American alligator) with access to a shallow estuarine impoundment. Bulletin of the Florida Museum of Natural History 54(2): 13-49.

Abstract: I used a combination of stomach content and stable isotope analyses to examine intrapopulation and temporal variation in use of estuarine prey resources by *Alligator mississippiensis* (American alligator) with access to a shallow estuarine impoundment located on the northeast Atlantic coast of Florida. I used a multi-tissue stable isotope approach to examine temporal trends in trophic interactions. This study took place within the Guana River Wildlife Management Area located in Ponte Vedra, Florida. From 2010 to 2012, I collected stomach contents from 44 *A. mississippiensis* and stable isotope samples from a total of 127 individuals. Stomach contents indicated the principal prey taxa consumed on a short-term basis were invertebrates (ie insects and crustaceans) and small baitfish. Individuals of all sizes used estuarine, as well as freshwater prey resources; however, the importance of estuarine prey to the diet increased through ontogeny. Juvenile and sub-adult stomach contents predominantly contained freshwater insects, while adult diets mainly contained estuarine baitfish and crustaceans. I used stable carbon and nitrogen isotope ratios (δ13C and δ15N) measured in three tissues (blood plasma, red blood cells, scute keratin) differing in turnover rates to assess overlap and temporal variation in the isotopic niche and inferred trophic interactions of *A. mississippiensis* sub-populations. Isotopic niche and inferred trophic interactions of *A. mississippiensis* varied among size classes, sexes, years, and capture habitats. Overlap in isotopic niches of sub-populations was highest between sexes of similar body size and

for individuals captured in similar habitats within the same years. Temporal shifts in trophic interactions were most prevalent for juveniles and sub-adults, while adults demonstrated a higher degree of temporal stability in trophic interactions and niche specialization. These findings represent one of the few studies to examine intrapopulation variation in use of estuarine prey resources by *A. mississippiensis*. Results of this study should be useful to habitat managers designing and implementing conservation programs for coastal ecosystems in the southeastern United States, especially in light of the expected alterations in coastal habitat structure due to sea level rise and global climate change

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Company, J. and Pereda-Suberbiola, X. (2017). Long bone histology of a eusuchian crocodyliform from the Upper Cretaceous of Spain: Implications for growth strategy in extinct crocodiles. Cretaceous Research 72: 1-7.

Abstract: The long bone histology of a Late Cretaceous eusuchian crocodyliform from the Iberian Peninsula reveals clear variations in the cortical structure which reflects changes in the speed of bone deposition (ie skeletal growth) related to ontogeny. The presence of secondary woven-fibred bone tissue in the perimedullar region of the cortex, and the existence of an external fundamental system in the most external periostic cortex, which is a proxy for somatic maturity and effective cessation of growth, challenges the former idea that the growth strategy of extinct crocodylians fit in the typical ectotherm condition, according to which these animals grew slowly during life under an indeterminate growth strategy. The analysed specimen lived for a minimum of 16 years and the highest preserved apposition rates took place in an advanced ontogenetic stage. The study suggests that the general aspects of the modern crocodylian growth strategy were already in place in some lineages by the Cretaceous.

Pollard, A.S., Boyd, S., McGonnell, I.M. and Pitsillides, A.A. (2016). The role of embryo movement in the development of the furcula. Journal of Anatomy (doi: 10.1111/joa.12571).

Abstract: The pectoral girdle is a complex structure which varies in its morphology between species. A major component in birds is the furcula, which can be considered equivalent to a fusion of the paired clavicles found in many mammals, and the single interclavicle found in many reptiles. These elements are a remnant of the dermal skeleton and the only intramembranous bones in the trunk. Postnatally, the furcula plays important mechanical roles by stabilising the shoulder joint and acting as a mechanical spring during flight. In line with its mechanical role, previous studies indicate that, unlike many other intramembranous bones, furcula growth during development can be influenced by mechanical stimuli. This study investigated the response of individual aspects of furcula growth to both embryo immobilisation and hypermotility in the embryonic chicken. The impact of altered incubation temperature, which influences embryo motility, on crocodilian interclavicle development was also explored. We employed whole-mount bone and cartilage staining and 3D imaging by microCT to quantify the impact of rigid paralysis, flaccid paralysis and hypermobility on furcula growth in the chicken, and 3D microCT imaging to quantify the impact of reduced temperature (32-28°C) and motility on interclavicle growth in the crocodile. This revealed that the growth rates of the clavicular and interclavicular components of the furcula differ during normal development. Total furcula area was reduced by total unloading produced by flaccid paralysis, but not by rigid paralysis which maintains static loading of embryonic bones. This suggests that dynamic loading, which is required for postnatal bone adaptation, is not a requirement for prenatal furcula growth. Embryo hypermotility also had no impact on furcula area or arm length. Furcula 3D shape did, however, differ between groups; this was marked in the interclavicular component of the furcula, the hypocleideum. Hypocleideum length was reduced by both methods of immobilisation, and interclavicle area was reduced in crocodile embryos incubated at 28°C, which are less motile than embryos incubated at 32°C. These data suggest that the clavicular and interclavicle components of the avian furcula respond differently to alterations in embryo movement, with the interclavicle requiring both the static and dynamic components of movement-related loading for normal growth, while static loading preserved most aspects of clavicle growth. Our data suggest that embryo movement, and the mechanical loading this produces, is important in shaping these structures during development to suit their postnatal mechanical roles.

Sobral, G. and Müller, J. (2016). Archosaurs and their kin: The ruling reptiles. Pp. 285-326 *in* Evolution of the Vertebrate Ear - Evidence from the Fossil Record, Volume 59 of the series Springer Handbook of Auditory Research, ed. by J.A. Clack, R.R. Fay and A.N. Popper. Springer International Publishing.

Abstract: Archosauria includes birds, crocodylians, and a number of fossil groups such as dinosaurs and pterosaurs. They first appeared in the Early Triassic and since then have dominated terrestrial ecosystems. This chapter is a compilation of the available information on the inner ear morphology of archosaur crown groups and stem groups and an exploration of different aspects of the evolution of their otic anatomy. It is still not clear whether tympanic hearing was present in the basalmost members of stem archosaur clades. However, more derived taxa show a number of modifications that certainly improved their hearing sense, such as a larger metotic foramen and a more elongate cochlea. Impedance-matching hearing appeared many times independently in archosaurs, although it is currently problematic to know at which point this happened. In theropods, impedance-matching hearing appeared before the origin of birds and was retained in the crown-group. Pneumatization must play an important role in directional hearing and is likely to have influenced skull pneumatization in crocodylians. Exquisite sound production capacities were present not only in hadrosaurids but also in ankylosaurids. Elongation of the semicircular canals seems to be linked to the acquisition of a more upright posture and a more active lifestyle in archosaurs. Many crown groups show further elongation of the canals, with birds representing an extreme condition.

Kanhere, E. (2016). Bio-inspired underwater active and passive sensing. Pp. 53-75 *in* Biomimetic Microsensors Inspired by Marine Life. Springer International Publishing.

Abstract: Animals, for survival rely heavily on their sensing capabilities. May it be catching a prey, escaping from a predator, finding partners for reproduction or being aware of surrounding environment, senses have a very important role to play. It would not be an exaggeration to say that for a species to sustain itself and thrive through the evolutionary process, 'sensing' is probably the most decisive factor.

Jardine, T.D., Rayner, T.S., Pettit, N.E., Valdez, D., Ward, D.P., Lindner, G., Douglas, M.M. and Bunn, S.E. (2016). Body size drives allochthony in food webs of tropical rivers. Oecologia (doi:10.1007/s00442-016-3786-z).

Abstract: Food web subsidies from external sources ("allochthony") can support rich biological diversity and high secondary and tertiary production in aquatic systems, even those with low rates of primary

production. However, animals vary in their degree of dependence on these subsidies. We examined dietary sources for aquatic animals restricted to refugial habitats (waterholes) during the dry season in Australia's wet-dry tropics, and show that allochthony is strongly size dependent. While small-bodied fishes and invertebrates derived a large proportion of their diet from autochthonous sources within the waterhole (phytoplankton, periphyton, or macrophytes), larger animals, including predatory fishes and crocodiles, demonstrated allochthony from seasonally inundated floodplains, coastal zones or the surrounding savanna. Autochthony declined roughly 10% for each order of magnitude increase in body size. The largest animals in the food web, estuarine crocodiles (*Crocodylus porosus*), derived ~80% of their diet from allochthonous sources. Allochthony enables crocodiles and large predatory fish to achieve high biomass, countering empirically derived expectations for negative density vs. body size relationships. These results highlight the strong degree of connectivity that exists between rivers and their floodplains in systems largely unaffected by river regulation or dams and levees, and how large iconic predators could be disproportionately affected by these human activities.

Sakaguchi, K., Nevarez, J.G. and Del Piero, F. (2016). *Salmonella enterica* serovar Pomona infection in farmed juvenile American alligators (*Alligator mississippiensis*). Veterinary Pathology (doi: 10.1177/0300985816677149).

Abstract: A fatal epizootic of salmonellosis occurred in farmed juvenile American alligators in Louisiana. Six animals were examined. Gross lesions included severe fibrinonecrotizing enterocolitis, necrotizing splenitis, coelomic effusion, and perivisceral and pulmonary edema. Microscopic examination revealed severe necrotizing enterocolitis and splenitis with intralesional bacteria and pneumocyte necrosis with fibrin thrombi. *Salmonella enterica* serovar Pomona was isolated from intestine and lung. Clinical salmonellosis is a rare finding in reptiles and salmonellosis caused by *S*. Pomona is not previously reported in American alligators. Since *S*. Pomona is a commonly isolated *Salmonella* serotype from patients with reptile-associated salmonellosis in the United States, and since alligator meat is consumed and the skin is exported to numerous countries, risk of human and animal infection should be considered.

Wilkinson, P.M., Rainwater, T.R., Woodward, A.R., Leone, E.H. and and Carter, C. (2016). Determinate growth and reproductive lifespan in the American alligator (*Alligator mississippiensis*): Evidence from long-term recaptures. Copeia 104(4): 843-852.

Abstract: The perception that crocodilians exhibit indeterminate growth is common in the general reptilian literature. However, this assumption is frequently based on observations of immature and young adult animals and therefore lacks a complete understanding of adult growth patterns. Long-term mark-recapture studies appear to be the most certain method of determining growth patterns of adult crocodilians. From 1979-2015, we conducted a mark-recapture study of an American alligator (*Alligator mississippiensis*) population on the Tom Yawkey Wildlife Center (YWC) in coastal South Carolina to examine long-term growth patterns and the influence of age on multiple reproductive parameters. We found no discernible linear growth in 19 of 31 adult female and 7 of 19 adult male alligators over periods of 5-33 years. The mean maximum reproductive lifespan for female alligators on the study site was 46 years, and females continued to reproduce for an extended period of time after reaching maximum size. The Schnute growth model predicted that male alligators grew at a faster rate and attained a greater estimated mean terminal snout–vent length (SVL) than females (males = 186.9, $CI_{0.95}$= 184.5, 189.3 cm; females= 135.9, $CI_{0.95}$= 134.1, 137.8 cm) at the hypothetical age 75. In addition, the model predicted that males exhibited a greater estimated mean size (SVL= 182.0, $CI_{0.95}$= 179.6, 184.4 cm) and age (43 years) at which growth essentially ceased when compared to females (SVL= 131.4, $CI_{0.95}$= 129.5, 133.2 cm; 31 years). However, actual growth records of individual alligators suggested that the growth model may have overestimated the age at which male alligator growth ceased. The estimated mean earliest age at sexual maturity was 11.6 years ($CI_{0.95}$= 10.5, 12.8) for males and 15.8 years ($CI_{0.95}$= 14.5, 17.1) for females. We also documented that alligators on the site commonly live to 50 and can possibly live to >70 years of age. This study provides evidence that both male and female American alligators in a population in coastal South Carolina exhibit a pattern of determinate growth and adds to a growing list of studies suggesting crocodilians as a group exhibit this growth pattern rather than indeterminate growth. Our findings are important for modeling population growth and determining sustainable harvest rates, particularly for alligators living near their northern distributional limit where growing seasons may be shorter and onset of sexual maturity later than in more southern portions of their range.

Phosri, S., Jangpromma, N., Patramanon, R., Kongyingyoes, B., Mahakunakorn, P. and Klaynongsruan, S. (2016). Protective effect of crocodile hemoglobin and whole blood against hydrogen peroxide-induced oxidative damage in human lung fibroblasts (MRC-5) and inflammation in mice. Inflammation (doi:10.1007/s10753-016-0471-7).

Abstract: A putative protective effect of cHb and cWb against H_2O_2-induced oxidative damage was evaluated in detail using MRC-5 cells. In addition, the carrageenan (Carr)-induced mouse paw edema model and the cotton pellet-induced granuloma model were employed to examine the in vivo anti-inflammatory activity of cHb and cWb in mice. It was demonstrated that both cHb and cWb treatments significantly increased cell viability and inhibited morphology alterations in MRC-5 cells exposed to H_2O_2. Orally administered cHb and cWb significantly reduced Carr-induced paw edema volume and cotton pellet-induced granuloma formation. Moreover, cHb and cWb decreased the expression levels of important pro-inflammatory cytokines (IL-6, IL-1β, and TNF-α), while only cWb was found to increase the expression of the anti-inflammatory cytokine IL-10 significantly. Finally, the activity of antioxidant enzymes (SOD, CAT, and GPx) in the liver improved after cHb and cWb treatment under acute and chronic inflammation. Taken collectively, the results of this study suggest that both cHb and cWb protect against hydrogen peroxide-induced damage in fibroblast cells. Moreover, cHb and cWb were found to exhibit anti-inflammatory activity in both the acute and chronic stages of inflammation and appear to enhance antioxidant enzyme activity and decrease lipid peroxidation in the livers of mice. Therefore, this study indicates that cHb and cWb have great potential to be used in the development of dietary supplements for the prevention of oxidative stress related to inflammatory disorders.

Kluczkovski Júnior, A., de Francisco, A., Kluczkovski, A.M., Da Silveira, R. and Markendorf, F. (2016). Fatty acid profile of the Amazon caiman protein concentrate. Journal of Food and Nutrition Research 4(10): 699-702.

Abstract: Some species of fish and other aquatic organism are important sources of protein and fatty acids that are beneficial to human health and can be industrially processed. The fatty acid profile of *Melanosuchus niger* (native to the Brazilian Amazon flooded forest) was determined in samples of a protein concentrate (PC) there was obtained from processing residues. The PC was

prepared from cooked muscle portions and NaCl (1.5%) using an adiabatic process. Saturated fatty acids such as stearic acid (0.59%) and palmitic acid (1.43%) were present. The levels of the unsaturated fatty acids omega-6 (ω-6) and omega-3 (ω-3) linolenic acids were 0.32% and 0.15%, respectively. In conclusion, Black caiman PC seems to provide essential fatty acids for human nutrition. Clinical studies are necessary to assess the influence of fatty acids from Amazon Caimans on human diet and the feasibility of obtaining new products such as nutraceuticals.

Seijas, A. (2016). Regional differences in growth rates of Orinoco crocodiles (*Crocodylus intermedius*) from the Venezuelan Llanos. The Herpetological Journal 26(4): 263-269.

Abstract: Populations of the Orinoco crocodile (*Crocodylus intermedius*) have not recovered from past exploitation, and current abundances cannot be used for assessing the suitability of habitats they occupy. Growth constitutes an alternative way of assessing habitat quality. Since 1990, more than 9000 captive-reared Orinoco crocodiles have been released into the Venezuelan Llanos. In the present study, the growth rates of 127 recaptured crocodiles from different regions were compared. All individuals from Middle Cojedes and the Aeolian savannahs grew slower than expected by the von Bertalanffy model, whereas individuals from Caños in the Apure floodplains grew faster than expected. These inferences are corroborated with growth rate measurements for crocodiles under four years of age, which were lowest in Middle Cojedes (average of 14.1 cm/year) and highest at Caños (43.3 cm/year). Low growth rates can be explained by habitat deterioration due to human activities, and high growth rates in the Caños support that the lower reaches of whitewater rivers offer favourable conditions for the species. Crocodiles in high quality habitats may reach sexual maturity in six years, whereas more than a decade is required in poor-quality habitats.

Pérez-Flores, J., Charruau, P., Cedeño-Vázquez, R. and Atilano, D. (2016). Evidence for wild crocodiles as a risk for human leptospirosis, Mexico. EcoHealth (doi:10.1007/s10393-016-1196-7).

Abstract: Sentinel species such as crocodilians are used to monitor the health of ecosystems. However, few studies have documented the presence of zoonotic diseases in wild populations of these reptiles. Herein we analyzed 48 serum samples from *Crocodylus acutus* (n= 34) and *C. moreletii* (n= 14) from different sites in the state of Quintana Roo (Mexico) to detect antibodies to *Leptospira interrogans* by means of a microscopic agglutination test (MAT). *Crocodylus acutus* and *C. moreletii* tested positive to 11 and 9 serovars, respectively, with Grippotyphosa being the serovar with the highest prevalence in Cozumel island (100%), Banco Chinchorro Biosphere Reserve (70.6%), and Río Hondo (100%), while in Chichankanab Lake, it was Bratislava (75%). Titers ranged from 1:50 to 1:3200, and the most frequent was 1:50 in all study sites. *Leptospira* is present in fresh and saltwater individuals due to the resistance of the bacterium in both environments. Cases of infected people involved with crocodile handling and egg collection suggest that these reptiles could play an important role in the transmission of leptospirosis. Preventive medicine programs should consider the monitoring of reptiles, and testing the soil and water, to prevent outbreaks of leptospirosis in facilities containing crocodiles.

Cline, E.A., Dreschel, T.W. and Schonhoff, B.R. (2016). *Alligator missippiensis* (American alligator) nesting. Herpetological Review 47(3): 455-456.

McCann, F., Escobedo-Galvan, A.H. and Cupul-Magana, G.G. (2016). *Crocodylus acutus* (American Crocodile). Anthropogenic nesting. Herpetological Review 47(3): 456-457.

Platt, S.G. and Rainwater, T.R. (2016). *Crocodylus moreletii* (Morelet's Crocodile). Troglodytism. Herpetological Review 47(3): 457-458.

Abstract: Troglodytism (cave-dwelling) appears to be rare among crocodilians, having been reported for only four of 23 (17.3%) extant species (reviewed by Soomaweera *et al*. 2014. Rec. West. Austr. Mus. 29: 82-81). Nile Crocodiles (*Crocodylus niloticus*), Dwarf Crocodiles (*Osteolaemus* sp.), and Australian Freshwater Crocodiles (*C. johnstoni*) are known to inhabit waterbodies in caves (Wilson 1987. Cave Science 14: 107-111; Soomaweera *et al*. op. cit.), and False Gharial (*Tomistoma schlegelii*) trackways have been found entering caves (Steubing *et al*. 2004. Crocodile Specialist Group Newsletter 23: 11-12). We here report an observation of troglodytism by *C. moreletii* at a cave in northern Belize.

Siroski, P.A., Poletta, G.L., Latorre, M.A., Merchant, M.E., Ortega, H.H. and Mudry, M.D. (2016). Immunotoxicity of commercial-mixed glyphosate in broad snouted caiman (*Caiman latirostris*). Chemico-Biological Interactions 244 (2016): 64-70.

Abstract: The expansion and intensification of agriculture during the past 50 years is unprecedented, and thus environmental problems have been triggered at different scales. These transformations have caused the loss of habitat and biodiversity, and disruption of the structure and functioning of ecosystems. As a result of the expansion of the agricultural frontier in the recent past, many areas of the natural geographic distribution of the local wildlife, among them crocodilians and particularly the broad snouted caiman (*Caiman latirostris*), are being exposed to contaminants. The present study was designed to evaluate the effect of commercially-mixed glyphosate (RU) on some parameters of the immune system of *C. latirostris*. Two groups of caimans were exposed for two months to different concentrations of RU recommended for its application in the field, while one group was maintained as an unexposed control. The RU concentration was progressively decreased through the exposure period to simulate glyphosate degradation in water. After exposure, total and differential white blood cell (WBC), and complement system activity (CS) were determined. In addition, the animals were injected with a solution of lipopolysaccharide (LPS) from Escherichia coli to trigger an immune response and evaluate the parameters associated with it. The results showed that an effect of the herbicide on CS was observed, as animals exposed to RU showed a lower CS activity than animals from the negative control (NC) but not in total WBC. In the case of leukocyte population counts, differences were only found for heterophils and lymphocytes.

Cotts, L., Piacentini Pinheiro, A.E., da Silva Marinho, T. , de Souza Carvalho, I. and Di Dario, F. (2017). Postcranial skeleton of *Campinasuchus dinizi* (Crocodyliformes, Baurusuchidae) from the Upper Cretaceous of Brazil, with comments on the ontogeny and ecomorphology of the species. Cretaceous Research 70: 163-188.

Abstract: The Baurusuchidae is one of the most representative families of Crocodyliformes from the Upper Cretaceous of Brazil. Amongst the 10 recognized species of the family in the world, eight are recovered from Bauru Basin outcrops. Despite its relative diversity and abundance, information on postcranial elements of species of the family is scarce in the literature. *Campinasuchus dinizi* is a baurusuchid found in the neocretaceous redstones of the

Adamantina Formation of Bauru Basin (SE Brazil). The postcranial skeleton of the species is described based on five specimens, with the following bone elements identified: proatlas, intercentrum of the atlas; pedicles of the atlas; odontoid process; axis; 3 postaxial cervical vertebrae; 9 dorsal vertebrae; 8 caudal vertebrae; 7 ribs and gastralia fragments; 11 chevrons; 12 osteoderms; pectoral and pelvic girdle; humerus; radius; ulna; manus; femur; tibia; fibula; and pes. *Campinasuchus dinizi* has the smallest and most delicate postcranial skeleton when compared with examined Baurusuchidae, with an inferred body mass of approximately 28 kg. Some elements of the postcranial skeleton of *C. dinizi* are also comparatively more robust (eg neural spines higher and more developed; vertebral body thicker; pelvic girdle more proeminent; limbs more elongated) than in some notosuchians, such as *Mariliasuchus amarali* and *Notosuchus terrestris*, and extant crocodyliforms such as *Caiman latirostris* and *Melanosuchus niger*. The mostly straight limbs of *C. dinizi* indicate a terrestrial habit, and suggests a semi-upright to upright posture during locomotion. The first descriptions of postcranial bones of a young specimen of *C. dinizi* and osteoderms of Pissarrachampsinae as well as comments about the distinct anatomy of some of those elements are also presented.

Da Silva Mendonca, W.C., Marioni, B., Thorbjarnarson, J.B., Magnusson, W.E. and Da Silvera, R. (2016). Caiman hunting in Central Amazonia, Brazil. The Journal of Wildlife Management 80(8): 1497-1502.

Abstract: Hunting caimans (*Caiman* spp.) with baited hooks in the Brazilian Amazon represents one of the largest illegal wildlife industries in the world. Our objective was to evaluate the effects of water level, distance from settlements, and hunting effort on caiman meat production. In 2008, we accompanied 31 caiman hunting expeditions in and around a wetland protected area located in the Amazon-Purus interfluve in Brazil. We measured and weighed all captured caimans. We used simple and multiple linear regressions to analyze our data. The hunting technique is not selective for the capture of spectacled caimans (*Caiman crocodilus*) or black caimans (*Melanosuchus niger*) and occurs throughout the year. Fresh-meat production was similarly correlated with individualś weights for both species. Hunting success was strongly related to river level, distance from human settlements, and hunting effort. We estimated an annual production of 37,050 kg of meat from the study area, representing 3562 caimans harvested and gross earnings of $US18,500. Caiman hunting was the principal source of income for hunters and their families but resulted in low returns, and large black caiman were not taken, indicating possible overhunting.

Drumheller, S.K. and Brochu, C.A. (2016). Phylogenetic taphonomy: A statistical and phylogenetic approach for exploring taphonomic patterns in the fossil record using crocodylians. Palaois 31(10): 463-478.

Abstract: Actualistic observations form the basis of many taphonomic studies in paleontology. However, surveys limited by environment or taxon may not be applicable far beyond the bounds of the initial observations. Even when multiple studies exploring the potential variety within a taphonomic process exist, quantitative methods for comparing these datasets in order to identify larger scale patterns have been understudied. This research uses modern bite marks collected from 21 of the 23 generally recognized species of extant Crocodylia to explore statistical and phylogenetic methods of synthesizing taphonomic datasets. Bite marks were identified, and specimens were then coded for presence or absence of different mark morphotypes. Attempts to find statistical correlation between trace types, marking animal vital statistics, and sample collection protocol were unsuccessful. Mapping bite mark character states on a eusuchian phylogeny successfully predicted the presence of known diagnostic, bisected marks in extinct taxa. Predictions for clades that may have created multiple subscores, striated marks, and extensive crushing were also generated. Inclusion of fossil bite marks which have been positively associated with extinct species allow this method to be projected beyond the crown group. The results of this study indicate that phylogenies can and should be further explored for use as predictive tools in a taphonomic framework.

Submitted Publications

***LACERTA CROCODILUS* WAS THE KROKODEILOS (IN IONIAN GREEK) WATER REPTILE**. In the living Rhynchocephalia and Squamata the anal opening is an elongate slit that is transverse, while in the Chelonia the vent is more circular and simply roundish. The elongate and lengthwise cloacal vent opening in the Crocodylia (such as that of the Nile crocodile) is unique among the orders of living Reptilia.

Sometimes two theoretically conflicting alternatives can actually both be equally correct, but at different times and in different ways. One of these potentially confusing coincidences happened in 1749 when Carl Linnaeus originally named the only physical crocodilian in his collection of scientific specimens in Sweden (today known to be a spectacled cayman from Paramaribo, Suriname) as being the taxonomic category of recognizable reptile kinds that the historically famous crocodile of the Nile River in Egypt is in and belongs to (ie neither the turtles group, nor the lizards and snakes group, nor the then still unknown tuatara of New Zealand). This was accomplished through a paper by Hast (in a compendium publication produced by Linnaeus), which predated but significantly and directly contributed to the 1758 meaning of *Lacerta crocodilus* in the today legally important and retroactively designated as special 10th edition of Linnaeus.

The 1749 employment of the name *Lacerta crocodilus* Linnaeus by B.R. Hast, in his descriptions of physical specimens in Sweden, was published before 1758, and therefore the 1749 name *L. crocodilus* is today not available for active employment in zoology, and neither are any other Linnean publications of the genus *Lacerta* and the species *L. crocodilus* that were produced temporally prior to the 1758 dated 10th edition. Nonetheless, there was important information in the 1749 publication, and the later 1758 version of the same name relied upon the 1749 original for at least one item of diagnostic data.

The layout and presentation of the today available species-group name *Lacerta crocodilus* Linnaeus, 1758, was primarily a listing of citations to already published literature (often including numbered plates and figures) about various kinds of living crocodilians, worldwide. Thus, taken in its historical context, the 1758 list of synonyms (synonymy) in the 10th edition of Linnaeus was a collective group that included representatives in Asia (today's *Crocodylus porosus*), in Africa (today's *C. niloticus*), and in the New World with *Alligator mississippiensis* in North America, *C. acutus* on selected Caribbean and Pacific shores (and adjacent fresh water interiors) of the tropical Americas, the broad-snouted *Caiman latirostris* in Atlantic southern South America, and the spectacled *Caiman crocodilus* that is widespread in much of South and Central America. It has been aptly said that in this case Linnaeus "lumped nearly all crocodilians under the one composite species" (Stejneger 1933).

The synonymy of *L. crocodilus* was not arranged strictly chronologically, but a 1749 paper describing a Paramaribo spectacled cayman from the Dutch colony of Suriname, today's *Caiman c.*

crocodilus (Linnaeus, 1758) is located at the top ("Amoen. acad. 1. p. 121"), and a 1757 publication pertaining to the anatomy of the Nile crocodile in Egypt ("Hasselq. iter. 292") is positioned at the bottom. There is at least one citation ("Merian. sur. 49. f. 69") dated before 1758, because Merian's pictures of plants and animals from Suriname were published in 1719. The reason that Hast's paper ("Amoen. acad." in 1749) was placed as the first (top) citation in the 1758 edition of Systema Naturae is that the specimen, whose individual external appearance had been described in detail in 1749, was known to Linnaeus personally in 1758 and also earlier in 1749. It was presumably the first crocodilian specimen to reach Sweden (Kischlat *et al*. 2016). Similarly, the reason that Hasselquist's (1757 "iter. 292") book, apparently including details of personal observation about the anatomy of the Nile crocodile, was placed at the bottom of the list in the 10th edition of Linnaeus was to draw attention to it, because Hasselquist was a former student of his, and this successfully completed travel to Egypt and Palestine was recent good news.

In addition to its synonymy, the *L. crocodilus* entry in the 1758 (10th) Linnean classification included an opening statement (an abbreviated diagnosis) at the top, and then at the bottom a few brief characterizations taken from selected existing publications by other authors (not including Hast) were appended. It is clear that the diagnostic suite of external characters of being covered with scales, and having both of its two front paws with five fingers (the proximal three of them clawed), and having four functional toes per hind paw (with webs between some of them, and only the proximal three with claws), and importantly having the cloacal vent as a lengthwise slit, were all explained in the 1749 description of a single individual physical specimen (dead and in alcohol) in the Royal University at Upsala, Sweden, in 1749 and 1758 to the present (Kischlat *et al*. 2016). In contrast, the diagnosis in the 1758 edition of Systema Naturae did not directly mention the cloacal opening being longitudinal.

The lectotype of today's *Caiman c. crocodilus* is the Uppsala specimen said to be 60 cm snout-vent length by Marinus Hoogmoed and Ulrich Gruber in their 1983 (Spixiana) lecotype designation, and it was recently explicitly suggested to be the Hast specimen by Kischlat *et al*. (2016). Thus it is safe today to address the very peculiar circumstance that the 1749 ("Hast" or "Linnaeus") specimen is correct as the physical lectotype, and simultaneously it is also clear that the species-group name *Lacerta crocodilus* Linnaeus, 1758, was originally intended as a collective group with the Nile crocodile (krokodeilos in Ionian Greek) as its eponym.

Many prominent authors including Cuvier (1817), Boulenger (1889), Stejneger and Barbour (1917), Stejneger (1936), and Loveridge (1957) have asserted that *L. crocodilus* Linné belongs (wholly or in part) in the synonymy of the Nile crocodile of Egypt. These five examples are detailed as follows.

1. Cuvier (1817) on page 20 said "Le Crocodile vulgaire, ou du Nil (*Lac. Crocodilus*. L.)"; and there was no other reference to Linnaeus in the synoptic coverage in 1817 from Cuvier.

2. Boulenger (1889) on page 283, at the first entry in his "*Crocodilus niloticus*" synonymy, said "*Lacerta crocodilus*, part., Linn. S. N. i. p. 359 (1766)"; and this was the only listing of Linnaeus (1766 has all of the 1758 content, and two additional citations) in this world wide treatment of the living crocodilian genera and species by Boulenger.

3. Stejneger and Barbour (1917) on page 41, as the eponym and basis for the Crocodylidae family, said "*Crocodylus* (genus). Laurenti, Syn. Rept., 1768, p. 53. Type: *niloticus* = *Lacerta crocodilus* Linné in part"; and this assertion was repeated unchanged in the 1923 second, 1933 third, 1939 fourth, and 1943 fifth North American check list editions by Stejneger and Barbour.

4. Stejneger (1936) on page 137 said about the actively employed genus *Crocodylus* Laurenti, 1768, that "the genotype is *Crocodylus* '*niloticus* = *Lacerta crocodilus* Linné in part,' by subsequent designation of Stejneger and Barbour (1917: 41). For a full discussion of the question see the article on 'Crocodilian Nomenclature' by Stejneger (1933: 117-120)".

5. Loveridge (1957) on page 176, in his synonymy of the *Crocodylus* genus, and as the eponym of the Crocodylidae family and Crocodylia order, said "1768. *Crocodylus* Laurenti, Syn. Rept. p. 53. Type by subsequent designation of Stejneger & Barbour: 1917: *C. niloticus* Laurenti = *Lacerta crocodilus* Linnaeus (part)"; and that was the only Linnean crocodilian content in the 1957 definitive treatment of Africa by Arthur Loveridge.

In many instances, importantly including Cuvier (1807), Boulenger (1889), Schmidt (1928) and Medem (1981), the reason for calling the common spectacled cayman of Surinam at Paramaribo as *Caiman sclerops* (Schneider, 1801) was to avoid conflict with their own opinion that *Lacerta crocodilus* actually in a very real sense properly belongs in the synonymy of the Nile crocodile. None of these publications alleged that the Linnean (1749 and including 1758 or 1766) description was not based on a Paramaribo common cayman, but they all made the choice to employ a newer and younger (1801) name from Schneider.

The most prestigious example of employing the Schneider (1801) name for Linnaeus's cayman (today understood as an individual with Surinam through Amsterdam to Germany provenance) was when Cuvier (1807) said that "it is well depicted, as Mr. Schneider remarks, in figure 10, plate 104 of Seba, book 1, although this figure is made from a very young specimen. It is to this species that the specimen described by Linnaeus (Amoenit. Acad. 1. p. 151) belongs. Schneider also described it very well... but Seba could have been lead into error because he says that his specimen comes from Ceylon. It is on the contrary here the species the most common in Cayenne, that which is sent most frequently from Guyana, and of which we have the most specimens for which the country of origin is well-proven" on published pages 31-32 in French as "Le caïman à lunettes (*crocodilus sclerops*, Schneider). Il est fort bien représenté, ainsi que M. Schneider le remarque, dans la figure 10, pl. CIV de Séba, tome 1, quoique cette figure soit faite d'après un très-jeune individu. C'est à cette espèce qu'appartenoit l'individu décrit par Linnaeus (Amoenit. Acad. 1, p. 151). M. Schneider l'a très-bien décrite aussi... Mais Séba pourroit induire en erreur, parce qu'il dit que son individu venoit de Ceylan. C'est au contraire ici l'espèce le plus commune à Cayenne, celle qu'on envoie le plus fréquemment de la Guyane, et dont nous avons le plus d'individus dont la patrie soit bien constatée", and without any Linnean content in the Nile Crocodile of Georges Cuvier in 1807 (but see his seemingly contradictory 1817 quote, above). Note that Cuvier's (1807) page "151" (sic) in "Amoenit Acad. 1" is an accidental transcriptional error that should be corrected to p. 121, meaning pp. 121-123 (in "Linnaeus" = Hast).

Similarly, in the case of Stejneger (1901) compared with his later germane action and assertions, it could appear that he contradicted himself, because in 1901 he refuted the Fox (1901) allegation that *L. crocodilus* is the correct name for the Nile crocodile, while in 1917 and 1936 he put at least part of *L. crocodilus* in *Crocodylus niloticus* (agreeing with Loveridge's later opinion in 1957). The philosophical problem is that Stejneger was all three times correct, because Linnaeus had the Hast and other Paramaribo common caymans in

1758 and simultaneously his intended meaning of the species-group name *Lacerta crocodilus* was actually denoting the Nile crocodile's kind (those with a lengthwise, as opposed to any other kind of cloacal opening) of cold-blooded quadruped creature that crawls on its belly and is covered with scales and lays shelled eggs on land (as opposed to, for example, the Caudata group of salamanders and newts in the Amphibia, which also exhibits a lengthwise cloacal slit but lacks the scaly skin).

The argument in Stejneger (1901), in opposition to Fox (1901), was that because "the types of *Lacerta crocodilus* are still in existence" and because "it has been shown both by Loennberg and Andersson that the specimens which served Linnaeus as types for his descriptions belong to the species which is commonly known as *Caiman sclerops*" of the New World, it therefore would not be proper to restrict *L. crocodilus* to the Nile crocodile of Africa. This is the position currently employed in the CITES list, and it is not contradicted by any of the germane details or conclusions in Andersson's catalog from Stockholm in 1900.

Schmidt (1928) observed that "Stejneger and Barbour (1917)... cite *niloticus* Laurenti as the type of *Crocodylus*" and that "they also cite *Lacerta crocodilus* Linnaeus as referring in part to *niloticus*", and therefore *Caiman sclerops* was employed in 1928 by Schmidt. The current CITES name for the common spectacled cayman of Paramaribo, *Caiman c. crocodilus* (Linnaeus, 1758), agrees with Schmidt's *Caiman s. sclerops* remarkably closely, as detailed by Kischlat *et al*. (2016), which includes bibliographic details for the six (Andersson 1900; Hast 1749; Hoogmoed and Gruber 1983; Linnaeus 1758, 1766; Merian 1719) papers that were mentioned (but not cited) above, and also a quote from Andersson about Linnaeus's intention that *Lacerta crocodilus* was a very widely distributed taxon ("locus in Asiae, Africae, Americae fervidis") in 1758, as a species-group name.

Interesting is Hasselquist's (1757) employment of *Lacerta crocodilus* for the Nile crocodile of Egypt, which was repeated in the 1762 "Reise nach Palästina in den Jahren von 1749 bis 1752... Carl Linnäus" German translation published by Johann Christian Koppe, in Rostock, Germany, and in which the entire crocodile section remained in its original Latin.

In my opinion the allegation in Fox (1901) that Hasselquist restricted *L. crocodilus* to Egypt was an overstatement, because at the very bottom of species 53 (*Lacerta crocodilus*) in the last line he said "Partes externas descripsit Linnaeus Amoen. Acad. I. p. 122" which is Hast in 1749 about the cayman baby in alcohol that had a raised bony and back-curved ridge that (like the "bridge" on a pair of spectacles eyeglasses) connects from the front-point of one eye to that of the other. This spectacle ridge is a physical character not possessed by the crocodile of Egypt.

Keeping in mind that the 1762 Rostock version that Fox (1901) cited was Hasselquist (1757) Stockholm science and therefore predates the 10th edition of Linnaeus in 1758 and does not count, I today interpret Hasselquist as finding in Egypt the animal that he had expected from reading about them, and simultaneously he agreed with his professor back in Sweden that the best name for this distinctive (I stress the lengthwise cloaca) kind of reptile is the name introduced in the 1749 Hast (Amphibia Gyllenborgiana) description of a spectacled cayman baby of the kind that is common at Paramaribo, Surinam, South America, namely *Lacerta crocodilus* with the ancient Ionian Greek word "krokodeilos" as its eponym (the Water Crocodile of Egypt).

For scholars with classical language skills remains the question of exactly who among the ancient authors recorded the longitudinal or lengthwise cloacal vent as being characteristic of the Nile crocodile the earliest. Probably this distinctive opening on today's *Crocodylus niloticus* of Egypt in Africa had already been noticed and written about some considerable time before 1749, but perhaps not. Relatedly but in this case not scientifically and actually from Africa, I observe that each and every one of the baby New World (by today's knowledge) crocodilians in Seba's figures that showed the cloacal region, the vent's actual opening was distinctly an elongate slit and correctly directed longitudinally along the ventral midline in 1734-1735.

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