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COVER PHOTOGRAPH: From left, clockwise: 1. Wild Gharial being fitted with VHF transmitters. 2. Ashutosh Pripathi (Gharial Ecology Project) presenting summary of survey techniques to Forestry Department staff; 3. Catch team with Gharial. 4. Communal Gharial nesting site at Rithora Tighra, with three females and excavated nests. See pages 10-14 for update on status of Gharial population in India.

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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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Editorial

For some time now the CSG has been trying to assist Colombia to resolve a problem with ranched and wild harvested skins entering the legal trade in *Caiman crocodilus fuscus*, which in accordance with Colombian laws must be restricted to production through captive breeding. I have included an article in this Newsletter (pages 8-9) that summaries recent actions by the European Union and Colombia. Added to this now, is a recent Notification from CITES (No. 2016/017). This will all hopefully lead to improved management of *Caiman crocodilus fuscus* in Colombia.

Colombia has also submitted a proposal to CITES to transfer from Appendix I to Appendix II, exclusively for ranching [Resolution Conf. 11.16 (Rev. CoP15)], the population of *Crocodylus acutus* in the District Integrated Management of Mangroves Bay Cispatá, Tinajones, La Balsa and Area near, Córdoba Department. CSG members have provided comments to the Colombian Management Authority on early drafts of this proposal: the final text should be available by the end of April.

In January 2016 the CITES Standing Committee (SC66) recommended that all Parties suspend commercial trade in some specimens of rosewood from Madagascar, until a range of requirements are met. It also agreed that if Madagascar does not make significant progress about illegal use and trade in rosewood by 25 July 2016, it will consider a recommendation to all Parties to suspend commercial trade in all specimens of CITES-listed species from Madagascar at SC67 (October 2016). Should a total ban be recommended, there are clearly implications for the Nile crocodile management program that is currently being developed and implemented after a 4-year ban.

A summary report on the 3rd Regional West and Central Africa meeting, held in Abidjan, Côte d'Ivoire, on 8-10 December 2015, is on pages 6-8 (Fig. 1 below). This was a remarkable meeting, very well attended by regional countries.

It is truly pleasing to see the population of Indian Gharial (*Gavialis gangeticus*) in the Chambal River, is in better shape than has been generally reported in the past. A recent report by Jeff Lang (see pages 10-14) gives an excellent summary of what is being achieved within India. The main study with which Jeff has been involved - supposedly in his retirement - is inspirational for us "oldies".

The Best Management Practices Manual is now in the final drafting stages, integrating any additional comments from reviewers and from the CSG Steering Committee. It will soon be posted on the CSG website.

A Crocodile Symposium, organized by Dr. Mark Merchant and Professor Wu Xiaobing, will be held under the auspices of the 8th World Herpetological Congress (Hangzhou, China, 15-21 August 2016). The opportunity is being taken to update the CSG on progress with the Chinese Alligator Action Plan, and it is hoped that participating CSG members will be able to visit alligator facilities and habitats, and meet Chinese researchers, prior to the 8th WHC.

The 24th Working Meeting of the Crocodile Specialist Group will be hosted by SANParks at Skukuza Rest Camp, Kruger National Park, South Africa, on 23-26 May 2016. The theme of the working meeting is "Crocodiles, Communities and Livelihoods". There will be a veterinary workshop on 21 May, and a meeting of the CSG Steering Committee on 22 May. Details, including the proposed Program, are now available on the meeting website (www.csg2016southafrica.org). The deadline for Abstracts is 30 April 2016. The CSG Executive urges all CSG members and others interested in crocodilian conservation, management, research and trade to consider participation in the meeting.

Professor Grahame Webb, *CSG Chairman*.

Figure 1. Some of the participants at the 3rd regional West and Central Africa meeting. From left, Samuel Martin, Vincent Lapeyre, Nathalie Kpera, Georges Hedegbetan, Grahame Webb, Ekke Waitkuwait, Joaddane Donaye Dekoua, Cyrille Mvele, Christine Lippai. Photographs: Christine Lippai.

Proceedings of 23rd CSG Working Meeting (Louisiana, USA; May 204) now available

The Proceedings of the 23rd CSG Working Meeting (Lake Charles, Louisiana, USA, May 2014) are now available as an electronic version (www.iucncsg.org - under Publications) and hard copy.

Registered participants who attended the Working Meeting will receive a complimentary copy of the Proceedings. Additional copies are being offered at $US35, to help cover the costs of postage. Please contact Dr. Mark Merchant directly (mmerchant@mcneese.edu) for further information.

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

SUMMARY OF WORLDWIDE CROCODILIAN ATTACKS FOR 2015. At CrocBITE (www.crocodile-attack.info) we compile records of crocodilian attacks worldwide from all time periods. For 2015 we recorded 323 attacks resulting in 151 deaths from 37 different countries (Tables 1-4) and 13 different crocodilian species (Table 5). While each year our methods and sources for obtaining crocodilian attack records improve, there are still some notable gaps in our data. Much of the range of the Nile crocodile (*Crocodylus niloticus*) has generally poor reporting in regards to attacks. In many of these countries (eg Burundi, Ethiopia, Somalia) reporting is virtually non-existent, while in other countries (eg Democratic Republic of the Congo, Malawi, Mozambique, Uganda) the small number of records we find or receive are a small fraction of the attacks that actually occur.

Table 1. Crocodile attack statistics for Africa in 2015.

Country	Fatal	Non-fatal	Total
Angola	3	4	7
Botswana	1	3	4
Dem. Repub. of Congo	8	0	8
Guinea-Bissau	2	0	2
Kenya	3	1	4
Madagascar	2	1	3
Malawi	6	0	6
Mozambique	5	1	6
Namibia	8	1	9
South Africa	1	1	2
Sudan	1	0	1
Swaziland	0	1	1
Tanzania	1	3	4
Uganda	3	0	3
Zambia	7	7	14
Zimbabwe	7	6	13
Totals - Africa	**58**	**29**	**87**

Table 2. Crocodile attack statistics for Asia in 2015.

Country	Fatal	Non-fatal	Total
Brunei	1	0	1
India	20	38	58
Indonesia	26	38	64
Malaysia	13	8	21
Nepal	1	1	2
Philippines	1	3	4
Sri Lanka	10	3	13
Timor-Leste	2	1	3
Totals - Asia	**74**	**92**	**166**

Table 3. Crocodilian attack statistics for the Americas in 2015.

Country	Fatal	Non-fatal	Total
Argentina	0	1	1
Brazil	3	6	9
Colombia	1	2	3
Costa Rica	0	2	2
El Salvador	0	1	1
Guyana	0	1	1
Jamaica	0	1	1
Mexico	7	20	27
Panama	0	1	1
Peru	0	2	2
USA	3	7	10
Totals - Americas	**14**	**44**	**58**

Table 4. Crocodile attack statistics for Oceania in 2015.

Country	Fatal	Non-fatal	Total
Australia	0	7	7
Papua New Guinea	5	2	7
Totals - Oceania	**5**	**9**	**14**

Namibia, South Africa, Zambia, and Zimbabwe are exceptions, and a wealth of attack data have been identified for these regions. For the Saltwater crocodile (*C. porosus*) the entire island of New Guinea (particularly the Indonesian provinces of Papua and West Papua) continues to be problematic in regards to attack data collection. A source in the Purari River Delta of Papua New Guinea provides some records for Gulf Province every year (and suggests attacks are frequent) and a few reports from the islands of New Britain and Bougainville usually reach the media but the vast majority of attacks are not reported or are only reported at a local level. The same is true of the Solomon Islands, and in 2015 we did not find or receive a single attack record from the archipelago, although it seems likely that attacks occurred. In addition, Timor-Leste is no longer reporting crocodile attacks

Table 5. Crocodilian attack statistics by species for 2015.

Species	Fatal	Non-fatal	Total
Crocodylus niloticus	56	29	85
Crocodylus porosus	55	61	116
Crocodylus palustris	21	33	54
C. porosus or *C. palustris*	3	0	3
Crocodylus acutus	5	17	22
Crocodylus moreletii	2	8	10
C. acutus or *C. moreletii*	0	1	1
Crocodylus suchus	2	0	2
Crocodylus johnstoni	0	3	3
Melanosuchus niger	3	7	10
Alligator mississippiensis	3	7	10
Caiman crocodilus	1	1	2
Caiman latirostris	0	2	2
Caiman yacare	0	1	1
Tomistoma schlegelii	0	4	4

on a consistent basis (the fisheries website appears to have stopped adding attacks in early 2014; http://peskador.org/incident.php) despite attacks continuing to be frequent; most reports now come from social media (eg photos of victims and/or crocodiles killed in retaliation posted on Facebook) or on rare occasions a Tetum language media source. In contrast, reporting from Indonesia appears to be improving and even attacks from remote provinces such as Maluku and North Maluku are now reaching the media. However, even given the increased level of news media reports, recent HCC surveys we conducted in the Kupang and Malaka regencies of West Timor, East Nusa Tenggara province revealed that only 54.5% of attacks from the 2007 through 2015 period were reported in the news media, with the remainder being recorded through village surveys and through contacting the local BKSDA offices. This suggests that a potentially high number of attacks continue to go unreported even in the Indonesian provinces for which we have records, particularly in the more remote provinces where online news media reports remain our only source of information.

There were several notable attacks and attack trends this year, including record worst years for fatal attacks in two areas and a fatal attack by what is generally considered to be an inoffensive species in another area. 2015 was the worst year on record for fatal *C. porosus* attacks in Sarawak (Malaysia) with a total of 13 attacks resulting in 9 deaths (the previous worst was in 2013 when 12 attacks resulted in 7 deaths).

It was also the worst year on record for fatal attacks in Mexico with a total of 27 attacks, resulting in 7 deaths. The Mexican attacks were attributed to the American crocodile (*C. acutus*) (16 attacks resulting in 5 deaths) and Morelet's crocodile (*C. moreletii*) (10 attacks resulting in 2 deaths); in one non-fatal case the culprit species was undetermined as both species were present in the immediate area. Of particular note is the very high level of conflict with *C. acutus* in the Lazaro Cardenas area of Michoacan State, particularly within the Barra de Santa Ana Estuary where 4 attacks resulting in 2 deaths were reported (one of the fatal attacks was caught on video); the total number of attacks for the Lazaro Cardenas area was 8 (including the 4 attacks in Barra de Santa Ana). In addition, a fatal *C. acutus* attack was reported from Nichupte Lagoon in the popular tourist destination of Cancun in Quintana Roo State; this is the first death we have recorded from the area, although non-fatal attacks are not uncommon. The fatal *C. moreletii* attacks occurred in Tabasco State (Balancan) and Quintana Roo (near Chetumal and the Belizean border).

This was also a particularly notable year for *C. porosus* attacks in East Kalimantan Province of Indonesia, where 11 attacks resulting in 8 deaths were reported. These attacks ranged from Balikpapan north through the Mahakam River Delta (Kutai Kartanegara regency) into East Kutai regency (particularly the Sangatta and Bengalon Rivers). Apparently, a large number of crocodiles were killed in East Kutai regency in response to the increased attack frequency (Rima News). The total number of reported attacks in Borneo (including Brunei, Kalimantan and Malaysia) in 2015 was 34 resulting in 22 deaths. Interestingly, for the 2007-2015 period the Malaysian state of Sarawak (in western Borneo) and East Kalimantan (Indonesian eastern Borneo) have the same number of fatal attacks reported (37 each), although it is possible some fatal attacks were unrecorded for East Kalimantan during the earlier years prior to active compiling of data (2007-2010). This is unlikely to be the case in Sarawak as attacks are believed to be comprehensively recorded within the state (CrocBITE 2016).

In a small number of cases worldwide each year it is difficult to determine exactly which species is responsible for an attack. This is most often the case when two potentially dangerous species inhabit the same area. In 2015 there were 3 fatal attacks reported from the Eastern Province of Sri Lanka in areas where both *C. porosus* and the Mugger (*C. palustris*) are present. Both species have been responsible for many fatal attacks in Sri Lanka in recent years, so this made identifying the culprit very difficult; these attacks took place in Panama, Pottuvil and Batticaloa (CrocBITE 2016). No crocodile surveys have been conducted in Sri Lanka's Eastern Province, although both species are known to be present in each area. Although older maps of the *C. porosus* distribution in Sri Lanka limit the species to the western and southern coasts, this is not the case and the species is actually found along the eastern coast from Panama to as far north as Trincomalee (Samarasinghe 2014; Rom Whitaker, pers. comm.).

In January an infant was reported to have been killed by a crocodilian in the Issa Oristuna reservation area of Sabanas de San Angel municipality in Magdalena, Colombia. All evidence suggested the culprit in the attack was likely a Spectacled caiman (*Caiman crocodilus*) (CrocBITE 2016). While this may be surprising given the maximum size of the species and the general view that it does not pose a threat to humans, a small infant is well within the size range of adult caiman prey items (www.crocodilian.com 2016). While this is the first fatal incident we have recorded for the species, there

are numerous records of non-fatal incidents (both provoked and unprovoked), particularly within Colombia. From 2007 to 2015 we recorded 20 attacks involving *C. crocodilus* (including the aforementioned incident), mostly from Brazil and Colombia, but also single incidents from Suriname and Trinidad. While many of these incidents involved fishermen accidentally stepping on caiman and being injured by defensive attacks, some cases appeared to be unprovoked and even involved people walking on land (of particular note is an incident in 2009 in Trinidad when a woman sustained serious injuries when she was attacked by a caiman while crossing a bridge en route to her place of employment) (CrocBITE 2016).

The first fatal American alligator (*Alligator mississippiensis*) attacks since 2007 also occurred in 2015, with 3 deaths reported, including the first fatal attack ever recorded in Texas. On 3 July 2015 a 28-year-old man named Tommie Woodward was killed by a 3.4 m alligator at a location known as Adam's Bayou in Orange County, Texas. He had apparently ignored warning signs and warnings from local residents and proceeded to swim in the early morning hours. The other two fatal attacks occurred in Florida - one on 19 October within the St. John's River of Blue Springs State Park and the other on 13 November at a pond in Barefoot Bay; neither of these attacks was witnessed and death by alligator attack was determined postmortem (CrocBITE 2016).

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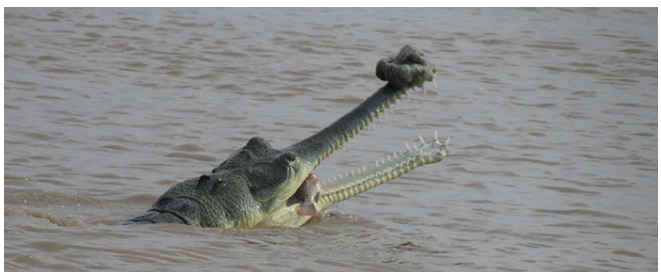
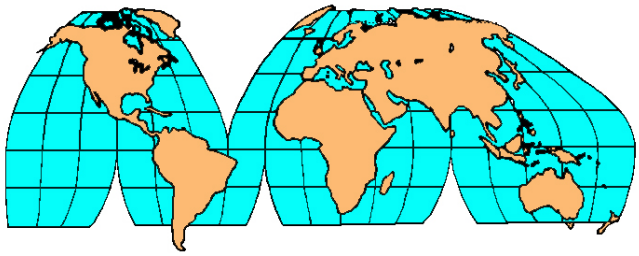


Regional Reports



West and Central Africa

THIRD REGIONAL WEST AND CENTRAL AFRICA REGIONAL MEETING. The 3rd West and Central Africa (WACA) Regional Meeting was held in Côte d'Ivoire on 8-10 December 2015. The meeting was convened at the University of Nangui-Abrogoua in Abidjan, and brought together a dynamic group of over 50 crocodile scientists from the region.

The theme for the meeting was "Crocodile Management Issues Across a Complex Landscape", and, the presentations reflected the diversity of research and approaches to conservation from Guinea in the west of the region to the Democratic Republic of the Congo in the east.

A successful fundraising drive ensured that sufficient funds were available to bring delegates to the meeting from 15 regional countries (Benin, Burkina Faso, Cameroon, Central African Republic, Côte d'Ivoire, Democratic Republic of Congo, Gabon, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal, Sierra Leone,Togo), representing government institutions, NGOs, universities and research institutions, and the private sector.

In addition, key crocodile conservation experts from beyond the African continent also attended the meeting, including CSG Chairman Professor Grahame Webb (Australia), CSG Regional (WACA) Chairmen, Dr. Samuel Martin (France) and Dr. Matt Shirley (Gabon/Cote d'Ivoire), CSG Regional (WACA) Vice-Chairman Christine Lippai (South Africa/USA), CSG IUCN Red List Authority Dr. Perran Ross (USA), and a full complement of CSG members from Europe and the USA. A full list of all participants will be available in the Proceedings.

Presentations dealt with various topics, including: the interaction between crocodiles and people; livelihoods and bush-meat trade; land-use planning and ecotourism; and, community management of wetlands. These are all key issues identified as common concerns throughout the region. An additional common issue revolved around the need for National Crocodile Conservation Strategies, which many believed would assist with crocodile management and conservation in their respective countries.

Selected key discussion points included the following:

- Bushmeat trade: this is a big issue in Nigeria and Gabon. In Nigeria, a rapid assessment was carried out to obtain

Figure 1. Founding members of the Young Crocodile Specialists of West and Central Africa Group, from left to right: Tobi Elie (Gabon), Daniel Konzin (Ghana), Christine Kouman (Cote d'Ivoire), Ilassa Ouedraogo (Burkina Faso), Georges Hedegbetan (Benin), Emmanuel Amoah (Ghana), Michel Ahizi (Cote d'Ivoire), Cyrille Mvele (Gabon), Akwasi Anokye (Ghana), and Stephane Kehou (Cameroon), pictured with CSG members Kim Lovich and Shawn Heflick, and Abidjan National Zoo volunteer Francesco Zezza. Photograph: Matt Shirley.

Figure 2. CSG participants, from left to right, Perran Ross, Matt Shirley, Ekke Waitkuwait, Grahame Webb and Samuel Martin, with some regional participants, from left to right, Cpt. Digbe (Cote d'Ivoire), Michel Ahizi (Cote d'Ivoire), Edem Eniang (Nigeria), Christine Kouman (Cote d'Ivoire) and Andre Zoh (Cote d'Ivoire). Photograph: Matt Shirley.

basic information on the situation regarding crocodiles. Respondents had overall negative views of crocodiles. A dangerous trend developing in the country is the harpooning of crocodiles at night, using bright lights. In addition, the national report from Nigeria noted that 20 years of data on crocodiles in the country did not show any evidence of a decrease in the number of Dwarf crocodiles on the bushmeat markets, except during the regional Ebola outbreak, which resulted in the Nigerian Government issuing notifications to stop eating bushmeat. The price of meat on the market was considered during the investigations and researchers found that the price is stable or even decreasing. Price fluctuation is due to many reasons, including the size/weight of the meat; previously it was based on the flavour or quality of the meat.

- Sustainable Hunting: in certain countries, professional trophy hunters will pay taxes at various levels and bring in revenue to the State. This can be a type of land management that is not in conflict with crocodile management and the trade in crocodilians can be a tool for their conservation. However, where corruption is a problem, this can result in disorder with hunting protocols and poaching can become the norm (eg in Gabon and Cote d'Ivoire).

- CITES: The potential for crocodile farming was discussed (eg in Nigeria), but recognised that land borders are porous throughout the region. The Garoua School in Cameroon deals with CITES issues and can accommodate CITES officials from the region to carry out training programs.

- Habitat Loss Oil spills in the Niger Delta of Nigeria and habitat loss in general are the greatest threats in southern Nigeria, and habitat loss throughout the region. It is difficult to ascertain whether a species' decline is due to habitat loss when the baseline data is lacking. Reintroduction programmes are complex for crocodilians as the historical distribution data is often lacking. Identifying critical crocodile habitat is important (Ghana, Cote d'Ivoire and Guinea).

- National Legislation: Crocodilians are integrally protected by national legislation in virtually all countries in the WACA region. The involvement of local people in national land management programs is important for crocodile conservation and application of national legislation *in-situ*.

- Climate Change: the impact of climate change on crocodile nesting viability needs to be considered given that the window of opportunity for fecundity and egg-laying can be impacted by temperature fluctuations.

- *Ex-situ* Conservation: Fabian Schmidt from Leipzig Zoo presented the European Studbook for Dwarf crocodiles (*Osteolaemus* spp.) which stimulated much discussion about relative hatching success between artificial and natural incubation. The take home message from Fabian's presentation was that Leipzig Zoo and other institutions participating in the EAZA *Osteolaemus* Studbook are able to supply Dwarf crocodiles for reintroduction programs. This presentation was complemented by that of Kim Lovich, describing all the opportunities for partnering with the international zoo community for both *in-situ* and *ex-situ* crocodile conservation work.

In addition to the various presentations and the national country reports, Perran Ross led an IUCN Red List Assessment for *Crocodylus suchus*. The meeting participants provided information on the species' occurrence in their respective countries and Perran facilitated the discussions, leading to the conclusion that the species merits the following listing: VU or EN under criteria A2, c & d:C1. An expert group was created, comprising Nathalie Kpéra, Ekke Waitkuwait, Stéphane Tchakoudeu Kehou, Shawn Heflick, Gabriel Segnagbieto and Matt Shirley, who will review the information and compile a submission to the IUCN Red List for final assessment by March-April 2016. Delegates were asked to send further information in order to complete the assessment.

Finally, the meeting considered the Regional Strategy Framework for Crocodilian Conservation, which had been drafted and circulated to the region following the 2nd Regional Meeting held in Burkina Faso in 2010. Three working groups were created; Conservation Biology, Legislation/ Management/Administration, Livelihoods and Trade. The groups were tasked with considering whether the framework document remained a valid working document for the region, and which aspects required improvement and update.

Following the meeting, a field training and workshop was held at Tai National Park for 10 regional participants from 6 different countries (Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Gabon, Ghana). The training covered crocodile-specific topics, such as spotlight surveys, species identification, and size class assessment, as well as going back to the basics with exercises in outboard motor boating, kayaking, GPS navigation, and even swimming. Participants had a chance to present their research and conservation projects as the basis for discussing project design, the scientific method, and project management, including funding sources, proposal writing, data management, and open-source software.

The week-long workshop concluded with the participants forming the "Young Crocodile Specialists of West and Central Africa" group (Jeune Spécialistes des Crocodiles de l'Afrique de l'Ouest et Centre), whose primary objectives are to establish a network of crocodile biologists in the region, facilitate communication, and, ultimately, hold annual training workshops.

The meeting proceedings are now being compiled, and should be available by May 2016.

Christine Lippai *(CSG Vice Chairman, WACA; lippainomad@gmail.com)* and Matt Shirley *(CSG Regional Co-Chairman, WACA; mshirley@ufl.edu)*.

Latin America and the Caribbean

Colombia

IMPROVED MANAGEMENT FOR *CAIMAN CROCODILUS FUSCUS* IN COLOMBIA NOW IN THE PIPELINE. In 2013, CITES Decisions 16.63 to 16.66 (CoP16) focussed on the improper use of source codes on CITES Export Certificates. Colombia's exports of *Caiman crocodilus fuscus* (Appendix II) were identified as a potential problem. Captive breeding is the only legally permitted production system in Colombia, so all exports have "captive bred" source codes. But skins from ranching and wild harvest, which is not legal in Colombia, were being included in exports by some producers.

This is clearly an infraction of CITES, and if not corrected, a CITES ban on exports could be imposed until the problem is solved. This is what recently happened in Madagascar. For Colombia, such a ban would stop all trade, which would damage all producers in their farming industry, regardless of whether they were involved in illegal trade or not.

At the 23rd CSG Working Meeting (May 2014) the consequences of Decisions 16.63 to 16.66 were discussed by the CSG with representatives of the Colombian Government and caiman farming industry. CSG advice to Colombia was that the illegal ranching could be overcome by legalising it. Ranching is a conservative harvest strategy, which generates livelihood benefits, and it appears to have been occurring and sustained for decades. Stopping the exports of large wild skins and flanks could perhaps be overcome by the judicious use of size limits. A legal wild harvest could of course be implemented in Colombia, if the non-detriment provisions of Article IV could be met. At the present time Colombia is under no obligation to comply with Article IV.

One year later, at the 1st East and Southeast Asia Regional CSG Meeting (May 2015), actions taken by Colombia were summarised. Responsibility for regulating Colombia farms had been transferred from the State (Department) level, back to the national level, under the Ministerio de Ambiente y Desarrollo Sostenible (MADS) - Colombia's CITES Management Authority. MADS had conducted on-site reviews on most farms (N= 44), and closed 7 (16%), because they did not have the stock or production capacity consistent with the CITES Export Certificates they were being issued. Colombia outlined a program for developing a legal ranching program.

There were two main points of discussion [CSG Newsletter 34(2): 12-14; Item 7.1]. Firstly, no actions were included to stop or control the trade in large skins and flanks from the wild. Secondly, the time frame for introducing a legal ranching was up to 5 years. The CSG questioned whether the Parties to CITES could, under the terms of the Convention, sanction the ongoing illegal trade while Colombia developed a new program. Three months later, at the 28th Meeting of the CITES Animals Committee (30 August to 3 September 2015), Colombia confirmed to the CSG that the pathway outlined in Cambodia was the one Colombia was going to follow, regardless of potential shortcomings.

This decision placed the CSG in a rather untenable position, because over and above encouraging countries to rectify problems, the CSG provides advice to the IUCN and others about the strengths and weaknesses of different programs. The CSG informed the Chair of the IUCN-SSC that there was nothing more the CSG could do to help Colombia overcome the compliance problems linked to CITES Decisions 16.63 to 16.66. It was a compliance rather than conservation issue and thus well outside the major thrust of the CSG.

The EU, which has consistently been active in CITES compliance issues, and were implicated in CITES Decisions 16.63 to 16.66, requested the CSG to provide information on the issues confronting Colombia. This information was subsequently summarised and submitted by the EU as an information document to the 66th Meeting of the CITES Standing Committee (January 2016) (https://cites.org/sites/

default/files/eng/com/sc/66/Inf/E-SC66-Inf-20.pdf). At SC66 the EU held fruitful bilateral meetings with Colombia, that resulted in a "Declaration" included within the Proceedings of SC66:

Declaration by Colombia regarding
Caiman crocodilus fuscus (SC66 Doc 41.1)

The European Union and Colombia held bilateral discussions during SC66 regarding trade of *Caiman crocodilus fuscus* skins from Colombia.

Colombia has been taking measures to prevent the illegal trade of *Caiman crocodilus fuscus* skins, and wishes to cooperate with the Parties to ensure the legal origin of the traded species.

In this sense, and aiming to strengthen the purpose of the Convention, Colombia has agreed with the European Union to undertake the following actions:

1. By 28 February 2016, Colombia will inform the Parties about regulations and mechanisms which enable the Colombian CITES Management Authority to monitor and control exports of *Caiman crocodilus fuscus* specimens, with a special attention being given to procedures that ensure that regulations are not circumvented on the occasion of the cutting of the skins.

2. By 31 May 2016, Colombia will inform the Parties about:
   - the population status and, if available, about studies, which are the basis to implement any future ranching programme of *Caiman crocodilus fuscus*;
   - perspectives and developments to establish a ranching programme, starting with selected pilot sites.

3. Colombia will establish a relevant export quota based on a non-detriment finding for ranched specimens originating from pilot sites as referred to under recommendation 2 by 31 May 2016.

4. Colombia will establish and implement a marking system for ranched specimens, which allow differentiating ranched and captive-bred specimens.

5. Colombia will clarify whether the current Colombian legislation prohibits the exports of skins over a certain size.

6. If such a prohibition exists, clarify whether existing legal measures enable seizing and confiscating illegally acquired skins. If this is not the case, adopt measures to seize skins larger than the size limit established by the Colombian legislation and ensure that these skins remain under control of the Colombian authorities. Such measures should be adopted by 28 February 2016 and implemented by 31 May 2016.

7. Colombia will report in writing its progress to SC67.

8. Colombia will request the Secretariat to issue a notification to the Parties informing progress made in the implementation of these measures.

(Colombia wishes this declaration to be included in the proceedings of the meeting).

The CSG welcomes this outcome and congratulates Colombia on its efforts to overcome the CITES compliance problems. The Colombian caiman farming industry is a sophisticated and innovative one, and if it require ranching and wild harvest to sustain itself, then those uses should be legalised and managed in accordance with Article IV.

Grahame Webb, *CSG Chairman, (gwebb@wmi.com.au).*

Cuba

REINTRODUCTION PROGRAM FOR CUBAN CROCODILE IN ZAPATA SWAMP, CUBA. The critical status of the Cuban crocodile (*Crocodylus rhombifer*) urges an integrative action that encompasses the study of the problems and an effective proposal of a plan of conservation for this endemic species.

In the recent past the Cuban crocodile was more widely distributed on the mainland Cuba (Gundlach 1880; Varona 1966), and skeletal material shows that this species was historically present on the Cayman Islands (Morgan *et al*. 1993) and in the Bahamas (Franz *et al*. 1995). The species is currently restricted to Zapata Swamp (Matanzas Province) and Lanier Swamp (Isla de la Juventud) (Rodriguez-Soberón *et al*. 2000; Ramos 1989; Varona 1976, 1983). In Zapata Swamp the population is restricted to an area of approximately 776 km^2, on the southwestern portion of the peninsula, and a nucleus of some 300 km^2 where the species is sympatric with the American crocodile (*C. acutus*) and hybrids between the two species (Ramos 2013).

The *C. rhombifer* population in this last locality was virtually extirpated during the mid-20th century. It is clearly defined that *C. rhombifer* is critically threatened, with a restricted geographical distribution as the main factor of risk. Commercial hunting had an effect on the distribution and abundance of the species and it had virtually disappeared from the eastern part of Zapata Swamp over the past 100 years, in a territory corresponding to 30% of its distribution.

A restocking program for *C. rhombifer* in areas where the species was extirpated, based on historical records of its distribution in the Zapata Swamp, was developed. The purpose of the project is to establish a viable and stable wild population using crocodiles reared in captivity in the Zapata Crocodile Farm.

This program as part of an ongoing restocking program carried out by the Empresa Nacional para la Protección de la Flora y la Fauna (ENPFF) - Ministry of Agriculture.

The restocking program is a component of the complete strategy of the conservation of *C. rhombifer*. The program took into account established criteria of the IUCN-SSC Re-introduction Specialist Group (1998, 2012), as well as available information on reintroduction programs in Cuba and other countries such as the USA, India, Philippines, Nepal, Zimbabwe, Uganda, Nigeria, Thailand, Vietnam, Venezuela and Colombia.

Zapata Swamp, with an approximate area of 657,900 ha, is located on the Zapata Peninsula, south of Matanzas Province, western Cuba. Most of this territory has protected area status, under the categories of Protected Area of Managed Resources, Wildlife Refuge, and National Park. The Zapata Swamp Biosphere Reserve was established in 2000, and since 2001 has been designated a RAMSAR site. The Zapata Peninsula also holds the status of Special Region of Sustainable Development (Decree 197/96, Plan Turquino-Manati).

One of the four potential areas for the liberation of crocodiles identified is a protected area with category of fauna refuge (Canales Hanabana), located in the Oriental region of the Zapata Swamp with an area of 5646 ha. This natural freshwater habitat of *C. rhombifer* was altered in the 1960s for agriculture purposes. This reserved area is formed by systems of canals, flooded terraces, patches of vegetation in the borders of the canals, pastures of swamp flooded in the spaces between canals.

On 28 January, 100 crocodiles (12 males, 88 females; 3-5-years-old), selected at the Zapata Crocodile Farm, were released. The average total length of animals was 114.8 ± 14.9 cm (range 94-162 cm) and average weight 7.3 ± 3.5 kg (range 4.0-19.5 kg). A high proportion (71%) of the animals were between 110 and 120 cm TL.

A monitoring program for the reintroduced population and the habitat will be implemented to evaluate the success of the program and obtaining the necessary knowledge on the species that will allow improvements to be identified.

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South Asia and Iran

India

It's time for an update on the Gharial conservation scene in India. Any additions would be most welcome, so we can have the most comprehensive update possible. Information can be sent to me at jeff.w.lang@gmail.com). We now have Facebook presence at "Gharial Ecology Project", featuring a short overview (5 min video clip).

This project, now in its 9th year, started in 2008 with Rom Whitaker and Dhruvajyoti Basu, and was initially sparked by the mass die-off of 110+ Gharial in the National Chambal Sanctuary (NCS). Fortunately, there hasn't been a recurrence of the mass mortality during the winter of 2007-08, but there is growing pressure for water extraction, illegal sand mining and fishing, as well as the ever present threat of major dams and diversions.

For the Gharial Ecology Project focused on the lower Chambal, we anticipate another several years at least, and are actively looking for handover partners within India who can keep the work going. Funded through the Gharial Conservation Alliance and private contributions in the beginning, the main supporters now are primarily from the international zoo community (Zoo Paraha, Ocean Park, Widllife Conservation Society, LA Zoo, Cleveland Metroparks, San Diego Zoo, San antonio Zoo, AZA-CAG and others), as well as help from generous donors such as participants in Crocfest events in Florida, CroctoberFest in San Diego, Swamp Girl Adventures, and others.

Every year/season, we learn a bit more, and now we have a fairly complete picture of how many Gharial populate the lower 225 km of Chambal where we "guess-timate" about 75% of the remaining megapopulation in the NCS resides. The non-hatchling numbers are in the 1500-2000 range, with at least 300+ reproductive-sized females, and probably 150+ "big ghara" males (4.5-5.5 m TL). Some 200-300 nests are produced each year, with >80% hatching, resulting in ~8000 hatchlings yearly.

These numbers are an order of magnitude above the usual figures referenced; eg "200 left in wild" and "less than 10 big males" for the entire species worldwide! This is without a doubt the most significant and most important stronghold of the species anywhere in the world, and coincides with prime habitat for the Ganges freshwater dolphin, two species of endangered hard shelled turtles, two species of large softshells, Indian skimmers, Saurus cranes, as well as major migratory flyway, in a protected, unpolluted large river - probably the only one within India of this size and scope. The Chambal Gharial are likely the only wild, free-living population that continues to live and thrive in an intact, large riverine habitat, where conditions are still favourable.

Our field work has recently shown that reproductive/nesting females travel long distances; our current longest traveler, back and forth on a seasonal basis, is a female we marked 100 km downriver at about the km100 mark (we reference all river locations as river distance in km from the Chambal-Yamuna confluence). She traveled upstream last season after being marked in November 2014, to a nesting sandbank at a turning in the river, 120 km from where she was tagged. She nested there, guarded her nest, opened it, and stayed with a large creche of 400-500 hatchlings until mid-July, then went 220 km downstream to the confluence as soon as monsoon waters flooded nesting banks and the creche dispersed.

In early December 2015 we tracked her back to this same nesting site, the entire 210 km distance, where she was part of a 50+ assemblage of large Gharial congregating and basking together. At this same site last year there were 31 nests counted, 27 of which hatched, producing two large creches separated by about 300 m. Each creche of 300-500 hatchlings

Figures 1-8 (from top left, clockwise): 1. Captured Gharial being tagged on mid-river sandbar. 2. A 5.3 m TL male Gharial tagged with VHF transmitter. 3. Tagged female Gharial being released. 4. Female #24, a long-distance mover (see text). 5. Getting locations, downloading GPS data. 6. Hatchling Gharials basking. 7. Illegal sand mining on the Chambal River. 8. GPS logger radio attached to dorsal surface of tail.

attended by an individual, big ghara male. These two males were more or less side by side within 500 m of shoreline, each attending a separate creche and patrolling an invisible boundary between the two nesting areas.

Our effective range now is this 210-km lower section of Chambal, about 170 km within Uttar Pradesh (with Madhya Pradesh across river), and the upper 40-45 km in Rajasthan (with MP across the river). We counted 153 nests along this entire stretch immediately after hatching this year (2015), 124 of which had hatched. There are probably another 50-75 nests upriver within the next 100 km, then the habitat and disturbance limit Gharial numbers in the upper reaches of Chambal, above about 300-350 km from confluence. There are animals there, but scattered, and populations are fragmented.

The other exciting finding, new these past several years, is the extent of complex social interaction, particularly around the creches. There are clearly defined "guardians" with the large creches, but these consist of a single dominant female, typically one of the largest nesting females at each colonial nesting site, and a big (>4.5 m) male, usually with ghara developed to at least half size, or larger. These guardian males are not necessarily the largest, dominant breeding males, but may be adjacent males not yet ready for "prime time." We have several solid scenarios in which a junior male is the guardian, and almost certainly *did not* participate in the breeding group nearby, where most of the nesting females courted and mated. These detailed observations strongly suggest "alloparental" behavior by the guardians, since they are the "surrogate" parents, rather than the actual parents of the majority or all of the hatchlings in creches they are guarding.

To date, we have tagged more than 50 Gharial with radios, and tracked some for 30+ months. We have 20+ Gharial radio tagged and continue to monitor them manually, as well as some with GPS loggers incorporated with the radios. These are remotely downloaded and provide fine-scale movement data (on daily basis for most animals) to augment and supplement the manual tracking. We have three researchers on the river on an almost daily basis, and they are well known and recognized by folks from all the river villages for at least the lower 170-km stretch, since they visit these sites regularly. These observers take photos and detailed notes, as well as track, and also discreetly monitor any other activities which appear to affect the Gharial and their presence at particular sites along the sandbanks, shorelines and deep pools.

Pankaj Kumar, Ramraj and Deepu Mishra continue to be the core field team doing the hard leg work of observing and tracking throughout the year. Soham Mukherjee has been an invaluable aide during the capturing and tagging efforts, with help from Munuswamy K, from MCBT. Ashutosh Tripathi has been coordinating and leading the training sessions with forest department staff, as well as primary and secondary school teachers. In addition, a local cadre of "gharial guards" is being assembled to help with monitoring riverside activities, and how these affect resident Gharial.

Besides water extraction and dam proposals, the most persistent threats are illegal fishing and sand mining. We have good connections with local Forest Department staff on both UP and MP sides of the river, and are in regular touch with them about river activities, etc. In the past several years, there has been an exponential increase in "industrial scale" sand mining on the extensive sand banks and bars, primarily in MP and Rajasthan. At the communal nest site where our long-distance mover nested last season (2015), sand mining was happening 24/7 during the pre-monsoon months, with 35-40 tractors and wagons plying up and down. At this site, sand removal resumed immediately post-monsoon and continues for 10 months (September-June) until the next monsoon.

The Gharial Ecology Project is operated through the MCBT, a 45-year-old registered Indian NGO. We are developing strong ties with the Laboratory for Conservation of Endangered Species (LACONES), a sister organization of Centre for Cellular and Molecular Biology, based in Hyderabad, the premier international government body doing world class research. We are tying up with LACONES to do genetic studies, aimed at establishing a Gharial database that will allow regional identification and within population level genetic relationships, as well as parentage of creche groups, to back up our behavioral observations. LACONES has a strong position in DNA-based wildlife forensics, primarily with megafauna such as leopards and tigers. Dr. Karthik Vasudevan, an alumnus from the MCBT, heads up herpetological research and is collaborating on crocodilian studies. We have also initiated a stable isotope study to better understand the prey base and food webs in the Chambal ecosystem, particularly for Gharial of different sizes, sexes and ages.

In addition to our work on the Chambal, I know of several other active Gharial projects that are on-going. One of these is being run by Subir Chowfin at Corbett Tiger Reserve in conjunction with Dr. Alison Leslie, who is helping write up their findings. There is a breeding population there of 100+ non-hatchling Gharial of mixed sizes. Estimates of adults are in the 30-50+ range, with recent increases in adults counted. There is sustained evidence of limited breeding in marginal, reservoir habitat, now that Ramganga River has been turned into series of lakes, that rise and fall pre-monsoon, with water control structures controlling water levels. The big plus at this site is the strict protection since these Gharial are residing in the middle of a famous National Park. Subir is an alumnus of the Gharial Ecology Project during 2008-10, and has established a long term study of Gharial in Corbett in his home state of Uttarakhand.

Another significant project is at Hastinapur, a 120-km protected area, set aside on the Upper Ganges, about 3 hours northeast of Delhi. Here, WWF-India has released about 100 juvenile Gharial per year from the Kukrail facility since 2010, so the released total now exceeds 500. I have been working with their biologist, Sanjeev Yadav (from Etawah) and we (with our fishing/catching crew from the Chambal) caught some of these released animals in late March 2015. We caught and tagged 7 juveniles just released a month earlier with radios (2 year duration) and 2 larger recapures that were initially released in 2010. Both were about 1.5 m and 5 kg

when released, and now the female is 75 kg, and 2.7 m, and the male 2.4 m and 40 kg. Both of these larger animals were tagged with GPS tags, as well as manual VHF tags, and at least the female has returned post monsoon right back to same spot, and the male has also returned to a downstream area.

We (Gharial Ecology Project/MCBT/GCA) donated the equipment, receiver and radios, etc., for this work, and are collaborating directly with WWF-India. The plan for 2016 is to tag more Gharial, and possibly start tagging some adult Batagur, large hard-shelled river turtles that are Critically Endangered as well. The habitats on the Ganges are totally different and degraded, but apparently at least some of the Gharial released there are thriving. I believe this is the most significant and successful Gharial release in India so far, and it goes a long way toward restoring this species in its native, original habitat - the female will need a larger male to breed with, and we are working on that component, hopefully by supplementing from captive breeding stock.

Other than these two projects, we also helped the Turtle Survival Alliance (TSA-India) carry out some tagging of juvenile Gharial released north of Lucknow, in the river system that runs out of the Katerniaghat barrage, Ghaghra and Girwa. Ten juveniles, again from the Kukrail facility, 3-5-years-old and 1.5-2 m in length, were released with radio tags, along with 52 others, some of these soft-release and some hard-release. Lonnie McCaskill was instrumental in getting some additional funding for this project, which is somewhat far afield from the usual turtle work TSA-India is doing. These Gharial were tagged and released at the end of February 2014, and have been intermittently tracked ever since. We (Gharial Ecology Project/GCA) donated the radio gear, radios and receivers, antennas, etc.

Only about half of these head-started Gharial survived post-release, through the first year at this site. But the one encouraging finding from the Ghaghra study is that the trackers were able to find evidence of a previously unknown "resident" population of Gharial in the river within 50-100 km below the dam at Katerniaghat, which suggests that the Katerniaghat population of 100-200 might be larger and more robust, and spread over more habitat, though presently unprotected outside the sanctuary. This Katerniaghat population is contiguous with the Nepal Bhardia population, the western one of two remaining wild populations within Nepal.

Other Gharial-related projects are of much smaller scale, and generally involve release of zoo-raised or captive-bred individuals into habitats not currently populated with Gharial. BC Choudhury and associates at the Wildlife Trust of India released some zoo Gharial in the upper reaches of Gandak, near the Nepal border on the UP-Bihar boundary, and some of these released animals have wandered around, up and downriver for 100s of kilometres. There is a plan to release more zoo Gharial in the Indus system in far western Punjab, near the Pakistan border, with help from WWF-India and others. The folks at Nandankanan, the first captive breeding facility set up by Dr. Robert Bustard and his team in Orissa, have been planning and/or actually released some Gharial into the Mahanadi River, Satkosia Gorge, which is now degraded and may no longer be suitable for Gharial in the long-term. Reports of Gharial in some of the smaller river systems in MP, below the Chambal-Yamuna confluence continue, in the Ken and Son, possibly the Betwa. These are fragmentary populations, isolated in "protected" areas, surrounded by unprotected stretches, where irrigation is major, and water extraction results in dry sections during the pre-monsoon period.

Overall, assembling a very rough estimate of Gharial numbers/populations, the total Chambal non-hatchling population is ~80% (+/-10%), or 2000 +/-500 animals, of the worldwide total of ~2500 (+/-500). Thus, it is by far the most significant and critical remaining stronghold for the species anywhere in the world. In brief, the remaining populations and their approximate numbers in India are Khaterniaghat-Ghaghra (150 +/-25) and Corbett (100 +/-25) and in Nepal are Chitwan (75 +/-25) and Bardia (75 +/-25). Gharial may still survive sporadically in Bangladesh, and in formerly occupied riverine habitats within India (Brahmaputra, Ganges, Gandak, Mahanadi, Ganges, Son, Ken, Yamuna, Betwa). All of these figures are very approximate, but on balance give a good indication of size relative to one another.

Recently, I was in touch with Iri Gill, Deputy Curator at London Zoo, about a Gharial conservation initiative that the London Zoological Society (LZS), with all its resources, is planning in Nepal. This Gharial initiative is just part of a comprehensive "range country" program that LZS has had in Nepal for decades, with major tie ups with tigers and other species. Iri just spent 10 days with us on the Chambal during the recent catching and tagging (17-26 November 2015), and is planning a workshop in November 2016 in Nepal to jump-start their program there. Initially, the emphasis will be on captive breeding, since this is the existing program there, with Bed Khadka and team, but there will likely be a parallel program up and running as soon as possible to shift the major conservation effort toward the wild populations, particularly at Bhardia and at Chitwan. The tentative plan is to draw on the Indian side to visit and advise on-site in Nepal, as part of the workshop.

Rom, Zai and I continue to dialogue about GCA, and the best way forward. We are in the process of drawing up an updated GCA mandate and operational procedure, and identifying an Indian-based coordinator. We are committed to continuing the initiative, in spite of the hiatus caused by staff changes at the MCTB, and an important period of re-imagining and re-examining its role and structure. With solid support for Gharial conservation from the international zoo community, in the USA and Europe as well as in Asia, the GCA will likely move toward becoming the main priority-setting advisory board with zoo representatives and a panel of overseas and south Asian experts.

In the meantime it is particularly important that the focus remain on the most significant remaining population worldwide, namely the Chambal Gharial (~80% of global population). The remaining four populations (Corbett and Katerniaghat in India; Chitwan and Bardia in Nepal) account

for the remaining 20% (roughly 5% each). The real challenge is how to protect and conserve this unique species in its natural habitats.

Jeff Lang *(Senior Advisor, Gharial Ecology Project, Madras Crocodile Bank Trust, jeff.w.lang@gmail.com)* with inputs from the Gharial Ecology Project team, Rom Whitaker *(Founding Trustee MCBT)* and Zahida Whitaker *(Director, MCBT)*.

GHARIAL CONSERVATION IN NATIONAL CHAMBAL SANCTUARY, INDIA. The National Chambal Sanctuary (NCS) in northern India is a legally protected nature reserve that offers excellent conditions for eco-tourism in the region. The important wildlife species present in the riverine section of the NCS are the Gharial (*Gavialis gangeticus*), the Mugger (*Crocodylus palustris*), 7 species of freshwater turtles (*Asperidetes gangeticus*, *Lissemys punctata*, *Chitra indica*, *Batagur kachuga*, *B. dhongoka*, *Pangshura tentoria* and *Hardella thurgii*), the Gangetic dolphin (*Platanista gangetica*) and the otter (*Lutragale percipelleta*). A variety of fish also occur in the Chambal River, and around 120 species of birds were identified in the NCS. Other important terrestrial animals present in the ravines of the sanctuary are land monitor lizard, variety of lizards and snakes, sambhar, spotted deer, jackal, hyena, fox, wolf, langur, porcupine, hares, desert cat, blue bull, wild boar, etc.

Chambal River

The Chambal River, one of the best remaining habitats for the Gharial in its range, originates in the Vindhyan range near Mhow in Madhya Pradesh (MP). It flows in a northeastern direction, passing through Rajasthan up to Pali and thereafter it flows in eastern direction, forming the boundary of MP and Rajasthan and MP and Uttar Pradesh (UP). It joins the Yamuna River near Barecha of Etawah District of UP. The Yamuna, in turn, flows in a southeast direction, till it meets the Ganga River at Allahabad. Kali Sindh, Parbati, Banas and Kunoo are the important tributaries of the Chambal River. A series of multipurpose dams at Gandhi Sagar (MP), Rana Pratap Sagar (Rajasthan), Jawahar Sagar (Rajasthan) and Kota barrage (Rajasthan) have been erected in the upper reaches of the Chambal River.

National Chambal Sanctuary

During 1978 the Chambal River was declared as a Crocodile Sanctuary under Crocodile Project with an aim to provide fully protected habitat for the conservation and propagation of the Gharial and other wild animals. The NCS extends over the Chambal River from Jawahar Sagar Dam to Kota barrage and after a gap of 18 km. free zone, from Keshoraipatan (Raj.) through Pali to Pachanada (UP) where Kunwari, Pahuj and Sindh rivers form a confluence with the Yamuna River. The total length of the river inside the sanctuary is about 600 km. The width of the river that is included inside the sanctuary is 1000 m from either bank in Rajasthan and Madhya Pradesh. Uttar Pradesh has a greater width, totaling to an area of 635 km^2. Geographically, the sanctuary lies between the latitude

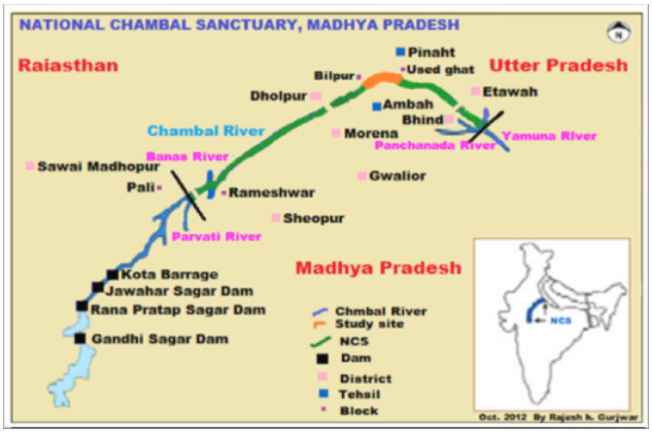

Figure 1. Map of Chambal River declared as National Chambal Sanctuary, India.

Figure 2. Chambal River.

250 35' N and 26052' N and longitude 760 28' E and 790 01' E.

Wildlife habitats:The habitat of aquatic wildlife in the Chambal River is characterized by expanses of open sand which is sparsely covered with a variety of herbs. The river-side vegetation is sparse in most of the southern (MP) side of the river. Both banks are muddy, formed by erosion of ravines adjacent to the river and the river depth varies from 1 to 20 m. Most of these banks are used for extensive agriculture. At some places one bank is sandy and other bank is rocky. Rocks are also present in the mid-river islands. Because of monsoon high waters the sand banks alter considerably making the steep sand banks into flat sand banks. In some stretches both the banks are rocky with alluvial deposits. The river is deep and fast and at some places shallow riffle areas are present. The overall topography of the Chambal River indicated that most of the south Chambal River has rocky beds compared to north Chambal River, where extensive sand banks are present.

Climate: The sanctuary is located in the northern tropical region where during a year three distinct seasons are distinguished. The duration of hot season is normally from 15 March to 30 June. The rainy season is from July to September. The area receives most of the rainfall from the southeastern monsoon. The winter season is from mid-October to February with minimum temperatures reaches 40^{o}C in January. Gales are very common during the summer season when wind velocity goes up to 12.4 km/h during June.

Crocodile Project in India

Efforts to conserve crocodiles in India effectively began in 1972 with the declaration of the Indian Wildlife Protection Act under which all three species of Indian crocodiles were declared totally protected fauna. A Nation-wide crocodile conservation project was initiated in by the Government of India during 1975 in technical collaboration with FAO/UNDP. Under the Crocodile Project many crocodile habitats were identified and protected by declaring 13 of them as crocodile sanctuaries. Among them 7 (54%) sanctuaries with an area of 2986 km^2 are specially created for the protection of Gharial. Under the National Crocodile Project wild crocodile eggs are collected, hatched in artificial hatcheries, and hatchlings reared in captivity until they are four years of age (1.2 m TL), ready for to release back into natural protected environments.

History of Gharial conservation

NCS is one of the major crocodilian sanctuaries specially created for the protection of Gharial and other wildlife. Management is emphasized on Gharial conservation. Stopping fishing activity, maintaining full protection from poaching, extending protection to habitat and rehabilitation of Gharial under the 'Grow and release' scheme are the management strategies adopted in the NCS. Forest Departments of all three states, MP, UP and Rajasthan are involved in the management of the sanctuary.

Fishing was totally banned and protection staff posted all along the river keep regular vigil. They also carry out Gharial census, monitor the released Gharial and search for Gharial nesting sites. The field staff protects nests *in-situ* by placing wire mesh over them to prevent predation by jackal and other animals. Similarly, they also protect turtle nests.

Every year the UP and MP Forest Departments collect several hundred Gharial eggs for captive rearing. All the newly hatched Gharials are reared carefully in specially designed rearing pools. Suitable areas in the sanctuary were identified for releasing the 1.2 m long reared Gharial. All the places chosen for releasing of Gharial were free from human disturbances.

Activities allowed and prohibited in Chambal

The Chambal River is a protected area. Illegal activities like catching of fish and other wild animals, including migratory birds, is prohibited. Sand mining is also prohibited inside the sanctuary. Activities like research, tourism are allowed in the Chambal River.

Research

Research studies have been undertaken on crocodiles and their habitat characteristics in the NCS through Jiwaji University, (Gwalior, Madhya Pradesh, India). Postgraduate studies carried out under the supervision of Prof. R.J. Rao, are:

1. Sitaram Taigor(2009). Studies on Impact of Sand Mining on Wildlife Habitats in the National Chambal Sanctuary, Madhya Pradesh. PhD
2. Hari Singh (2011). Habitat Characteristics, Population Dynamics and Conservation of Aquatic Mammals (Dolphin and Otter) in National Chambal Sanctuary, Madhya Pradesh, India. PhD
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4. Hari Singh (2007). Status and Conservation of Gangetic River Dolphin in National Chambal Sanctuary in India. MSc.
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East and Southeast Asia

Philippines

CROCODILE COMMUNITY AWARENESS FOR RESOURCE EDUCATION (CARE) CAMPAIGN IN SIARGAO ISLANDS PROTECTED LANDSCAPES AND SEASCAPES (SIPLAS), SOUTHERN PHILIPPINES. The "Symposium on Crocodiles: Their Ecological Importance and Benefits to Human" was held on 30 September 2015 at the Surigao State College of Technology (SSCT)-Del Carmen Campus, Municipality of Del Carmen, Surigao Del Norte. The status of crocodiles in Siargao Island was presented to about 900 secondary and tertiary level students highlighting the introduced Philippine crocodiles in Paghungawan Marsh. Although communities in the island knew of the presence of crocodiles around them, the ecological importance and the need to conserve crocodiles were unfamiliar to many.

The successful launching of the Crocodile CARE Campaign in SIPLAS followed the symposium on 13 November 2015. After several diligent dialogues, the Department of Education (DepEd) Division of Siargao issued a Division Memorandum No. 112, s. 2015 and Corrigendum No. 142, s. 2015 supporting the conduct of public awareness campaigns in secondary schools.

A total of 2920 students from 24 public schools participated in the series of lectures, film showing, and eco-games. DENR-PASU Office technical staff and members of the community-based people's organization Jaboy Ecotourism and Conservation Organization (JECO) joined in the campaign. A resource person from JECO presented the

ecological importance of conserving crocodiles and its habitat as well as the benefits to be derived from it. Delivered in their local dialect, the CARE message was sent across in a clearer and more relevant manner to the audience. Active audience participation was rewarded with information campaign collateral such as printed pens, button pins and souvenir magnets.

A Philippine crocodile mascot "Mindoy" (derived from the species name "*mindorensis*") was introduced during the launch. It proved to be an effective instrument in gaining the interest of the young audience, portraying the crocodile as a friend. Mindoy was a product of the Mascot Design Contest held exclusively for Mindanao students to encourage local visual arts talents in their appreciation of crocodiles.

The winning entry, designed by a fresh graduate of the Caraga State University, echoes the distinctive happy Filipino culture in a crocodile. Mindoy's red vest reflects the tribal design of the IP community while the hat is iconic of the native Filipino. Anatomic features were changed with artistic licence to render the mascot more appealing and approachable. Mindoy is a jolly, charismatic crocodile mascot who befriends students and teachers alike in every school he visits.

Figure 1. Philippine Crocodile Mascot "Mindoy" in action at the Crocodile CARE Campaign in SIPLAS, 2015.

The presence of a mascot readily attracted the attention of students and teachers of all ages. Everyone was keen to take a selfie or group photo with Mindoy during the closing part of each event. It is anticipated that a more positive public perception could be achieved with an adorable and friendly Mindoy playing the role of crocodile ambassador.

Although important, capturing the audience's attention and putting them in a more receptive mindset is only one of the many campaign strategies. Understanding the drivers of human-crocodile conflicts and demonstrating the ecological importance of crocodiles to wetland ecosystems also helped to neutralize the pessimistic views of the respondents. The initial view of the crocodile as "a ferocious animal with no benefits to humans" apparently eased up soon after the awareness campaign was initiated. Feedback from students and faculty at each visit reflected heartfelt appreciation for new learnings and enlightenment regarding crocodiles, its habitat, and the need for conservation. As a consequence, Mindoy and the Crocodile Care campaign were invited to join in the World Wildlife Day celebration at SIPLAS.

The Crocodile CARE campaign in SIPLAS also encourages the sustainable use of resources for ecotourism. The introduced population of *C. mindorensis* in SIPLAS has already been made part of the nature interpretation tour organized by JECO. Trained eco-tour guides promote community-based sustainable tourism for the enhancement of public awareness and appreciation of the marsh. Ecotourism-related structures such as a visitor reception center, a viewing deck, and an observation-cum-monitoring tower have been installed in strategic places. JECO members actively participate in the biophysical monitoring program and regular patrolling. Twenty-two trained community members have been deputized as Wildlife Enforcement Officers (WEOs) under the DENR Regional Special Order No. 2015-555 last October 14, 2015. They have been tasked to help stakeholders in enforcing environmental laws that would support the implementation of Community-based Sustainable Tourism (CBST) in Paghungawan Marsh.

Crocodile habitats in SIPLAS are among the priority ecotourism destinations included in the SIPLAS Ecotourism Management Plan 2016-2020 which allows soft-impact activities in the protected area. JECO's strong commitment and volunteerism in establishing community-based sustainable ecotourism in the locality has been recognized by the Caraga Regional Ecotourism Committee in their Committee Resolution No. 2014-02 "Endorsing the Paghungawan Marsh Adventure Tour, a community-based sustainable tourism in Brgy. Jaboy, Pilar, Surigao Del Norte" adopted on August 6, 2014. Likewise, the municipal local government of Pilar acknowledged the need for continuing efforts in increasing crocodile awareness and appreciation by passing Municipal Resolution No. 67, Series of 2015 dated 26th of October 2015 declaring the month of May as "Crocodile Conservation Month" for the Municipality of Pilar, Surigao Del Norte. The said resolution was requested by the Barangay Council of Jaboy through the issuance of Resolution No.14, Series of 2015 dated 5th of October 2015. The unwavering LGU commitment is a substantial catalyst for advancing crocodile conservation in Siargao Islands and a fitting model to replicate throughout the Philippines.

Acknowledgements

We extend our warmest gratitude to the Association of Zoos & Aquariums - Crocodilian Advisory Group and CrocFest for providing financial aid to conduct capability building and crocodile CARE campaign projects. We would also like to thank all our partner institutions including JECO, DepEd-Division of Siargao, Caraga Regional Ecotourism Committee, Protected Area Management Board and DENR-PASU Office, Barangay Council of Jaboy, and the MLGUs of Del Carmen and Pilar for their valuable contribution to the success of this awareness campaign project.

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East and Southeast Asia

Indonesia

RECENT RECORDS OF CROCODILES ON THE ISLAND OF SULAWESI, INDONESIA Very little is known regarding the status of crocodile populations on the island of Sulawesi. The saltwater crocodile (*Crocodylus porosus*) is the only species confirmed to be present on the island, although in the past there have been suggestions of as many as 3 other species (T*omistoma schlegelii*, *C. siamensis* and a possible undescribed species of *Crocodylus* reportedly found in the island's freshwater lakes) occurring there. The Saltwater crocodile was once widely distributed and abundant throughout Sulawesi, but populations were historically depleted by hunting, the collecting of wild specimens for use on farms and destruction of habitat (Platt *et al*. 2007). Information of the species' current distribution is limited, but records of sightings, captures and attacks on humans over the past 10 years suggest that the species is still widely distributed, although likely in much lower densities. Recent information suggests that in addition to habitat destruction, human-crocodile conflict (HCC) is also becoming an issue of significance to crocodile conservation (although to a much lesser degree than in many other parts of Indonesia). Reports of HCC can be used as important indicators of crocodile distribution. It is of course possible that attacks on humans may involve itinerant crocodiles wandering into new areas, although they can also be indicative of a resident population being present. For the period 2006-2015 we recorded 27 attacks on humans by crocodiles, resulting in 11 deaths (Table 1) and 44 incidents of crocodile sightings or captures reported in the media. It is possible that the number of attacks is under-represented due to a lack of reporting in remote areas and minimal information being available prior to the start of our collection of data (in 2010).

Table 1. Crocodile attacks in Sulawesi by province, 2006-present.

Province	Fatal	Non-fatal	Total
North Sulawesi	0	3	3
Central Sulawesi	1	5	6
West Sulawesi	2	3	5
South Sulawesi	5	1	6
Southeast Sulawesi	4	5	9
Total	**12**	**17**	**29**

North Sulawesi: Saltwater crocodiles have recently been found 30-40 km inland along the Dumoga River in heavily human-modified habitat, as well as along the southern coast at Kombot village (Platt *et al*. 2007). In addition, it was found that crocodiles were also present within the Talaud Islands regency on Karakelang Island (Platt and Lee 2000), in particular within the Rai River of North Beo sub-district (Discover Indonesia Online 2016). Recent records indicate that the species is present within the Ranoyapo River of Amurang sub-district in South Minahasa regency along the northern coast, from the river mouth to as far inland as Karimbow village where a non-fatal attack was reported in May of 2014. On the southern coast two non-fatal attacks were recorded, one from a beach at Rerer village in Kombi sub-district of Minahasa regency (the victim was apparently dragged from his tent on the beach) in June of 2014 and one from Buyat Lake (a freshwater lake) in Central Buyat village of Kotabunan sub-district in East Bolaang Mongondow regency in late December 2015 (CrocBITE 2016). A 2008 survey from the Sangihe Islands regency revealed a small resident population of crocodiles residing at Laine in South Manganitu sub-district on Sangihe Island (SulutIptek 2011).

Gorontalo: Saltwater crocodiles are reportedly present within the Cape Panjang/Randangan Estuary region along the southern coast of Gorontalo, although the long-term viability of this population was deemed questionable (Platt *et al*. 2007; Platt and Lee 2000). The species is claimed to have been extirpated from Lake Limboto near Gorontalo City as early as the 19th century following bounties being offered by the colonial government for captured crocodiles (Boomgaard 2007). No attacks on humans by crocodiles were reported during the study period.

Central Sulawesi: Historical records suggest that Saltwater crocodiles once inhabited Lake Poso, but have since been extirpated (Platt and Lee 2000). Slightly dated information also suggest that the species recently or still inhabits the Morowali Wetlands area, the Ranu Lakes and within suitable habitat in the Togian Archipelago (Silvius n.d.). Recent records reveal frequent sightings and interaction between humans and crocodiles within Palu Bay and the lower Palu River of Palu City, including at least 3 non-fatal attacks

(CrocBITE 2016) and a child that went missing while bathing in the river near where crocodiles had been sighted (no body is reported to have been found, so it is unknown whether or not a crocodile was involved) (Metro Sulawesi 2015). The Palu River itself appears to have little or no suitable crocodile habitat, which mirrors the aforementioned situation along the Dumoga River in North Sulawesi, where crocodiles are found in areas of heavy agricultural use (Platt *et al*. 2007). In addition, videos have been posted on YouTube of crocodiles basking at the Palu River mouth suggest that the crocodiles have very little fear of humans. There are historical records from the 1930s of HCC, including man-eaters, in Palu City. A non-fatal attack and captures have also been reported from the Tojo Una-Una regency (CrocBITE 2016), including multiple captures from Wakai within the Togian archipelago (Portal Ampana 2016). The single reported fatal attack in Central Sulawesi during the study period occurred at Muara Besar of Buga village in Ogodeide sub-district of Toli-Toli regency along the northwestern coast of the island (CrocBITE 2016).

West Sulawesi: Very little information exists regarding the historical distribution of crocodiles in West Sulawesi. There are historical references to HCC along the Lariang River in Mamuju regency. All of the attacks and sightings/captures we recorded for the study period came from the coastal Mamuju and North Mamuju regencies, particularly within the Pasangkayu sub-district of North Mamuju (CrocBITE 2016) The distribution of attacks suggest that crocodiles are widespread throughout coastal West Sulawesi, although densities and population status are unknown.

South Sulawesi: Saltwater crocodiles are known to inhabit the freshwater lakes of Matano and Mahalona (Platt and Lee 2000) and recent information suggests that the species is also present within the adjacent Lake Towuti which itself is adjacent to the Malili River which is also stated to hold a crocodile population. A fatal attack was reported from Lake Towuti in 2006 and a large (4+ m) Saltwater crocodile was killed in response (CrocBITE 2016). It has also been suggested that significant crocodile populations may be present within the Ancona and Cerekan Rivers along the Gulf of Boni (Platt *et al*. 2007). Historical records also exist for the freshwater Lake Tempe (Platt and Lee 2000) and there are recent records of attacks (including 2 deaths in 2014 and 2016), sightings and captures from the inland portions of the Walanae River which drains into Lake Tempe and Lake Sidenrang (CrocBITE 2016). These inland populations of Saltwater crocodiles suggest that the undescribed crocodile species historically mentioned to occur within the freshwater lakes of Sulawesi (Platt and Lee 2000) may have actually been the Saltwater crocodile. Recent crocodile sightings have also come from major population centers in South Sulawesi including Makassar City (Pojok Sulsel 2015), Palopo City (Sindo News 2013) and Pare-Pare City (Tribun Regional 2013). In May of 2013 a single 2 m crocodile was also reportedly captured on Tanakeke Island of Takalar regency (Okezone 2013).

Southeast Sulawesi: A Saltwater crocodile population is known to inhabit Rawa Aopa Watumohae National Park (Platt *et al*. 2007) and a monitoring team in December of 2010 spotted 36 crocodiles during a survey (Sugiarto 2012). In December 2006 two people were reportedly killed by crocodiles within the Roraya River, which is one of the rivers located within the national park. There were also reports of attacks and/or captures of crocodiles from within the Konawe (Pohara River), Kolaka and Bombana regencies during the study period. The species is also reportedly present on the islands of Buton and Muna within the Tiworo Islands. On Buton Island a fatal attack reportedly occurred in the Langkumbe River in July 2009 and a non-fatal attack was reported from the city of Baubau in January 2012. Attacks have also been recently reported from Muna Island, including a fatal attack along the Tiworo River in 2009 (CrocBITE 2016).

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East and Southern Africa

Madagascar

PRELIMINARY ASSESSMENT OF HUMAN-CROCODILE CONFLICT IN MADAGASCAR. Like many range states for *Crocodylus niloticus*, human-crocodile conflict (HCC) is a significant management issue in Madagascar. Here, we present a preliminary assessment of crocodile attacks, to better understand the distribution and cause of attacks.

Number of Attacks

Data on Nile crocodile attacks in Madagascar were compiled from various sources (eg DGF records, media reports, CrocBite), and incorporated in the Direction Générale des Forêts database. In all, 388 records of attacks were identified: 121 from 1892-1938 (the colonial period); and, 267 from 1987-2015.

Although data from 1892 (the earliest record) to 1938 provide useful information, the number of attacks in this period is considered to be well under-reported, and as such these data are of limited utility for quantifying trends over time. Likewise, the lack of records between 1939 and 1986 is considered to reflect a lack of reporting and/or the ability to locate records of attacks, rather than the absence of attacks.

Fatality Rate

The fatality rate for 1892-1938 (80.2%; N= 97) was higher than that reported for 1987-2015 (56.2%; N= 150). It is possible that non-fatal attacks in 1892-1938 were less likely to be reported, and the difference in fatality rate between the two periods may reflect under-reporting. The fatality rate for 1987-2015 (56%) is similar to that reported for *C. niloticus* by Fergusson (2004) (63%) and *C. porosus* in Sri Lanka (Stevenson *et al*. (2014). Pooley (2014) reported a fatality rate of 49.2% for *C. niloticus* in South Africa and Swaziland .

Sex and Age of Victims

Considering the 159 records where the sex of victims was available, males comprised the majority of attacks (71.7%).

Of the 61 records where the age of victims was known, a high proportion (36.1%) of victims were children (1-15 y) (Fig. 1). The average age of victims was 26.4 y (range 2 to 70 y).

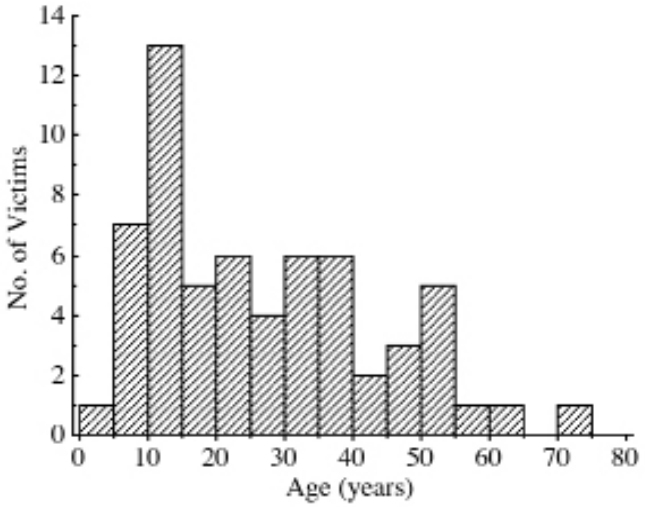

Figure 1. Distribution of victim ages (N= 61).

Month of Attack

Most attacks have occurred in the warmer months of the year (October-May; Fig. 2), which also coincides with the rainy season (most annual rainfall is received in December-March). There was an average of 14.5 attacks per month in October-May relative to 6.3 per month in July-September. The higher frequency of attacks during the warmer times of the year, when crocodilians are more active, is common to many crocodilians (eg Manolis and Webb 2013; Conover and Dubow 1997; Fergusson 2004).

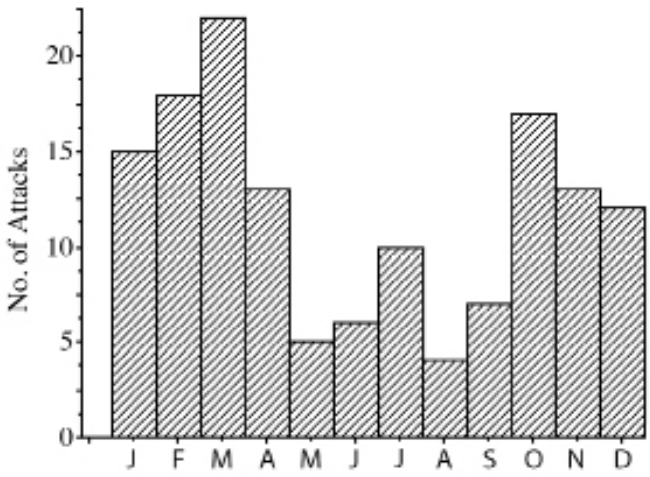

Figure 2. Monthly distribution of crocodile attacks (N= 142).

Trends

Within 1987-2015 there appear to be two distinct periods of high attack frequency: 1990-1995 (average of 24.8 attacks per year); and, and 2008-2015 (average of 12.0 attacks per year) (Table 1; Fig. 3).

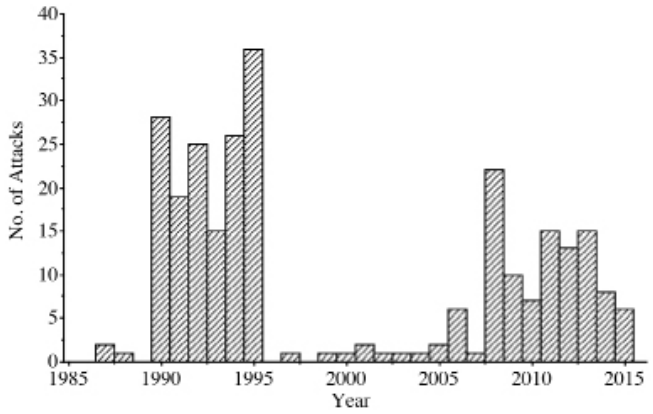

Figure 3. Numbers of crocodile attacks per year, 1985-2015.

Table 1. Frequency of crocodile attacks, 1987-2015.

Period	No. of Years	No of Attacks	Mean Attacks Per Year	Range
1987-1988	2	3	1.5	1 to 2
1990-1995	6	149	24.8	15 to 36
1996-2004	9	8	0.9	0 to 2
2005-2007	3	11	3.7	1 to 6
2008-2015	8	96	12.0	6 to 22

The reasons for the decline in attack reports between 1990-1995 and 2008-2015 are not known. The majority (94.0%) of attacks in 1990-1995 were reported by Behra (1996), and there are no details available on them. This period coincides with Madagascar's attempts at CITES to maintain *C. niloticus* on Appendix II pursuant to ranching, and extensive fieldwork allowed information on attacks to be collected by direct interview. After the successful Appendix-II listing was achieved in 1997, efforts to collate information were largely restricted to media and Provincial authorities, although some data were collected during egg collections. More recently, the CrocBite website became an important source of important. Reporting of attacks is also affected by local beliefs about crocodiles.

Activity at Time of Attack

There are limited data available on the activity of victims at the time of the attack. They suggest that fishing and crossing rivers are the most common activities of victims (Table 2).

Table 2. Activity of victims at time of attack.

Activity	Males	Females	All
Crossing waterway	13	2	21
Fishing	8	6	16
Bathing	4	-	7
Drawing water	1	5	7
Washing	-	3	4
Other	1	-	4
Unknown	87	29	213

Size of Crocodile

Information on size is only available for 7 crocodiles involved in attacks, of which 5 were estimated to be 3-5 m long, and 2 were relatively small (0.7 and 1.5 m TL).

Distribution of Attacks

The general distribution of crocodile attacks in different regions for the pre-1938 and post-1986 periods are on Figure 4. Interestingly, the distribution of attacks varied between periods. However, the post-1986 distribution is considered to represent the current areas with high levels of HCC - that is, the northern, western and southeastern parts of the country (Fig. 4). The western distribution has the highest densities of *C. niloticus,* and population size (human and crocodiles) may be implicated in the distribution of attacks.

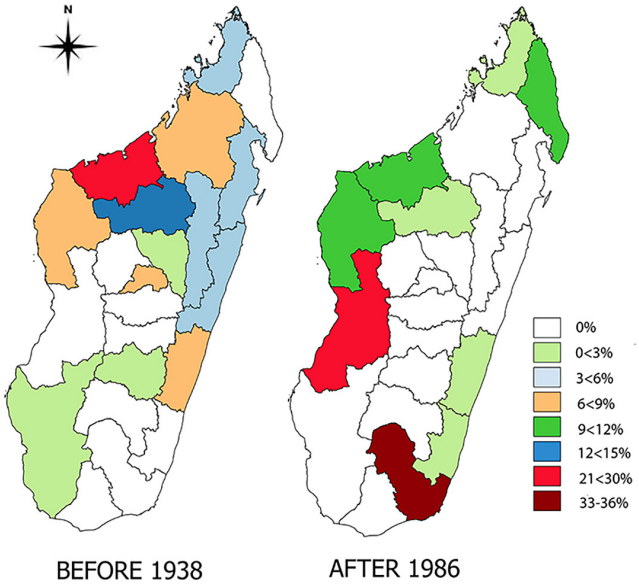

Figure 4. Distribution of crocodile attacks (expressed as % of attacks in each region) for 1892-1938 and 1987-2015.

Conclusions

A more detailed analysis of HCC in Madagascar is constrained by the lack of details for many attacks, and the fact that many attacks, particularly those that result in only minor injuries, probably go unreported. The absence of records over a 48-year period (1939-1986) is evidence of a lack of reporting. Although information from that period would be of historical interest, it would not necesarily be important for guiding management activities now.

Despite the lack of detail for many records, the available data nonetheless do provide some insights that can improve crocodile management. The activities that put people at risk of attack are associated with water, such as bathing, washing, fishing, etc. (Table 2). Rural livelihoods depend on waterways to large degree, and Crocodile Exclusion Enclosures (CEEs), such as those used in India and Sri Lanka (CSG 2016; De Silva 2011), could assist in the mitigation of HCC in Madagascar.

The distribution of attacks identifies areas where public awareness and education programs can focus in the first

instance. These areas also have the highest crocodile densities, although human population size and other factors are no doubt implicated in the higher levels of HCC.

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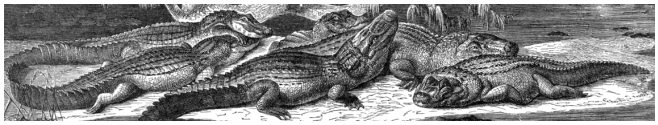
Science



Recent Publications

Hill, A.G., Denis, M.M. and Pyne, M. (2016). Squamous cell carcinoma with hepatic metastasis in a saltwater crocodile (*Crocodylus porosus*). Australian Veterinary Journal 94(3): 83-86.

Abstract: Squamous cell carcinomas (SCC) are uncommon in reptiles and there have been few reports of neoplasia in Australian crocodiles, despite increased numbers being raised in captivity. We report a locally invasive SCC in the hindlimb of a wild-caught saltwater crocodile (*Crocodylus porosus*) with hepatic metastasis. The gross appearance was soft tissue swelling adjacent to the nail bed, progressing to abscessation incorporating multiple toes. Diagnosis was achieved by biopsy during amputation of the affected toes. Hepatic metastasis was identified at necropsy, with a similar gross appearance resembling an abscess. Neoplasia is an uncommon finding in crocodilians and metastatic neoplasia is rarely documented. This is the first report of SCC in a crocodilian.

Wang, X., Cheng, G., Lu, Y., Zhang, C. Wu, X., Han, H., Zhao, Y. and Ren, L. (2016). A comprehensive analysis of the phylogeny, genomic organization and expression of immunoglobulin light chain genes in *Alligator sinensis*, an endangered reptile species. PLoS ONE 11(2): e0147704.

Abstract: Crocodilians are evolutionarily distinct reptiles that are distantly related to lizards and are thought to be the closest relatives of birds. Compared with birds and mammals, few studies have investigated the Ig light chain of crocodilians. Here, employing an *Alligator sinensis* genomic bacterial artificial chromosome (BAC) library and available genome data, we characterized the genomic organization of the *Alligator sinensis* IgL gene loci. *Alligator sinensis* has two IgL isotypes, λ and ϰ, the same as *Anolis carolinensis*. The Igλ locus contains 6 C_{λ} genes, each preceded by a J_{λ}gene, and 86 potentially functional V_{λ} genes upstream of $(J_{\lambda}\text{-}C_{\lambda})$n. The Igϰ locus contains a single $C_{\varkappa}$ gene, 6 $J_{\varkappa}$s and 62 functional $V_{\varkappa}$s. All VL genes are classified into a total of 31 families: 19 V_{λ} families and 12 $V_{\varkappa}$ families. Based on an analysis of the chromosomal location of the light chain genes among mammals, birds, lizards and frogs, the data further confirm that there are two IgL isotypes in *A. sinensis*: Igλ and Igϰ. By analyzing the cloned Igλ/ϰ cDNA, we identified a biased usage pattern of V families in the expressed Vλ and $V_{\varkappa}$. An analysis of the junctions of the recombined VJ revealed the presence of N and P nucleotides in both expressed λ and ϰ sequences. Phylogenetic analysis of the V genes revealed V families shared by mammals, birds, reptiles and *Xenopus*, suggesting that these conserved V families are orthologous and have been retained during the evolution of IgL. Our data suggest that the *A. sinensis* IgL gene repertoire is highly diverse and complex and provide insight into immunoglobulin gene evolution in vertebrates.

Sirsat, S.K.G., Sirsat, T.S., Price, E.R. and Dzialowski, E.M. (2016). Post-hatching development of mitochondrial function, organ mass and metabolic rate in two ectotherms, the American alligator (*Alligator mississippiensis*) and the common snapping turtle (*Chelydra serpentina*). Biology Open (2016) 0: 1-9. (doi: 10.1242/bio.017160).

Abstract: The ontogeny of endothermy in birds is associated with disproportionate growth of thermogenic organs and increased mitochondrial oxidative capacity. However, no similar study has been made of the development of these traits in ectotherms. For comparison, we therefore investigated the metabolism, growth and muscle mitochondrial function in hatchlings of a turtle and a crocodilian, two ectotherms that never develop endothermy. Metabolic rate did not increase substantially in either species by 30 days post-hatching. Yolk-free body mass and heart mass did not change through 30 days in alligators and heart mass was a constant proportion of body mass, even after 1 year. Yolk-free body mass and liver mass grew 36% and 27%, respectively, in turtles during the first 30 days post-hatch. The mass-specific oxidative phosphorylation capacity of mitochondria, assessed using permeabilized muscle fibers, increased by a non-significant 47% in alligator thigh and a non-significant 50% in turtle thigh over 30 days, but did not increase in the heart. This developmental trajectory of mitochondrial function is slower and shallower than that previously observed in ducks, which demonstrate a 90% increase in mass-specific oxidative phosphorylation capacity in thigh muscles over just a few days, a 60% increase in mass-specific oxidative phosphorylation capacity of the heart over a few days, and disproportionate growth of the heart and other organs. Our data thus support the hypothesis that these developmental changes in ducks represent mechanistic drivers for attaining endothermy.

Neamat Gamal Saleh Ahmed (2015). The Impact of Corporate Social Responsibility (CSR) on the Supply Chain (SC) Performance of the Luxury Fashion Industry. MSc thesis, Politecnico di Milano, Milan, Italy.

Abstract: The last decades have witnessed a remarkable increase in the attention paid towards the luxury fashion industry. The globalization, the awareness of the climate change, and sustainability issues pushed the luxury fashion companies to be less wasteful and more helping people to express their deepest values. On one hand, sustainability is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability implementation in the luxury industry, on the other hand, could be considered a vehicle not only to achieve a better environment but also to fulfill social development. Sustainability in luxury can also refer to maintaining the legacy of local craftsmanship. Recently, Luxury fashion companies started to pay more attention towards social sustainability and adapting Corporate Social Responsibility (CSR) practices within its culture and strategies. Luxury fashion companies are adopting social sustainability practices related to labor working conditions, and customer health and safety, human rights, society activities, and product responsibility, these practices are done in compliance with the law, legalizations, and the customer demands. Despite the fact that many researchers have discussed CSR, Supply Chain (SC), and the luxury fashion industry separately, a few of them have discussed the CSR in luxury companies leaving several aspects to be studied. Therefore, the goal of this research is to fill in the gap through investigating, 1) The CSR practices implemented in the luxury fashion industry; 2) The CSR key performance indicators used by luxury fashion companies; 3) The impact of the CSR aspects on SC performance of the luxury fashion industry. First of all, a detailed literature review covering the area of luxury fashion industry, CSR, and SC was implemented. Hence, this step helped in getting a solid background of the current state-of-the-art. Besides, the data from luxury fashion companies was collected. These data were collected from the sustainability reports and the official websites of 16 Italian and non-Italian luxury fashion companies in addition to the practical data of Mauri Shoes Company. Although many of luxury fashion companies had been contacted, most of them showed a negative attitude towards participating to the study and they did not agree to share the information of their company because of their restrictions policies. Then, the Global Reporting Initiative (GRI) guidelines were exploited in order to classify and categorize the collected data in order to build our research's database. The second milestone of the presented research was reached by using Computer Aided Text Analysis (CATA) software and through the analysis of the case study in order to figure out the framework of the relation and the impact of CSR on the SC performance, and also by performing a comprehensive interview with Mauri Shoes' CEO. Our database has been exported to CATA and then it has been coded according to: 1. GRI guidelines (categories, sub-categories, and its aspects); 2. The SC performance, which based on Supply Chain Operations Reference SCOR model. CATA software was used to explore the percentages of the CSR sub-categories (labor practices and decent work, human rights, society, and product responsibility) within our database. Furthermore, the CATA software was used in order to explore the relationship and the impact of the CSR sub-categories on the SC performance (cost, asset management efficiency, flexibility, reliability, and responsiveness). Then, a
detailed analysis was done to extract the relationship and impact of the CSR aspects on the SC performance. All these steps were explored and validated through the industrial case study. In the end, the current study proposed a general framework for CSR in relation with the SC performance. This framework could help the luxury fashion companies to optimize the implementation of the CSR in their supply chain strategies. A final comment could be made here declaring that this study can be considered as a start milestone in the long-term scientific research about the investigation of the impact of CSR practices in the different companies and various sectors of the industry and follow-on further research should be done in this field.

Pritz, M.B. (2016). Thalamic reticular nucleus in *Caiman crocodilus*: relationship with the dorsal thalamus. Neuroscience 322: 430-451.

Skupien, G.M., Andrews, K.M. and Larson, L.R. (2016). Teaching tolerance? Effects of conservation education programs on wildlife acceptance capacity for the American alligator. Human Diemnsions of Wildlife: An International Journal (doi:10.1080/10871209.2016.1147624).

Abstract: Growing populations of American alligators (*Alligator mississippiensis*) in human-dominated landscapes present a challenge to wildlife managers concerned with promoting coexistence between humans and alligators. Where structural fixes such as direct removal of animals are not viable options, cognitive fixes such as conservation education programs should be considered. We evaluated the effectiveness of two conservation education programs (classroom-based program, field excursion) on three outcome variables that help define wildlife acceptance capacity for American alligators: beliefs and attitudes, perceived risk, and potential for coexistence. We found respondents who took part in both education programs had more positive beliefs and attitudes toward alligators, and believed in a greater potential for coexistence than individuals in a control group who did not undergo either intervention. Control group respondents also perceived higher risk from alligators. These data suggest that conservation education programs can impact stakeholder beliefs, attitudes, and perceptions, ultimately influencing acceptance capacity for predators.

Johnston, S.D., López-Fernández, C., Arroyo, F., Fernández, J.L. and Gosálvez, J. (2015). The assessment of sperm DNA fragmentation in the saltwater crocodile (*Crocodylus porosus*). Reproduction, Fertility and Development (http://dx.doi.org/10.1071/RD15300).

Abstract: Herein we report a method of assessing DNA fragmentation in the saltwater crocodile using the sperm chromatin dispersion test (SCDt) after including frozen-thawed spermatozoa in a microgel (Halomax; Halotech DNA, Madrid, Spain). Following controlled protein depletion, which included a reducing agent, sperm nuclei with fragmented DNA showed a homogeneous and larger halo of chromatin dispersion with a corresponding reduced nucleoid core compared with sperm with non-fragmented DNA. The presence of DNA damage was confirmed directly by incorporation of modified nucleotides using *in situ* nick translation (ISNT) and indirectly by studying the correlation of the SCDt with the results of DNA damage visualisation using a two-tailed comet assay (r= 0.90; P= 0.037). Results of the SCDt immediately following thawing and after 5 h incubation at 37°C in order to induce a range of DNA damage revealed individual crocodile differences in both the baseline level of DNA damage and DNA longevity.

Moreno-Bernal, J.W., Head, J. and Jaramillo, C.A. (2016).Fossil crocodilians from the High Guajira Peninsula of Colombia: Neogene faunal change in northernmost South America. Journal of Vertebrate Paleontology (doi: 10.1080/02724634.2016.1110586).

Abstract: The La Guajira Peninsula, Colombia, has a continuous vertebrate fossil record that includes both the late early-early middle Miocene and the Pliocene. Crocodilians from the early to early middle Miocene Jimol and Castilletes formations include gavialoids, recovered from both coastal and shallow marine deposits, and caimanines representing early records of the specialized caimanine taxa *Purussaurus* and *Mourasuchus*. Crocodyloid specimens from the Pliocene Ware Formation are assigned to *Crocodylus* and represent one of the oldest occurrences of the genus in the New World. Records from the La Guajira Peninsula suggest that diverse crocodilian assemblages were already established by the late early Miocene, including several widely distributed lineages that persisted for several million years. *Crocodylus* is a recent immigrant to South America that occupied habitats left vacant by the extinction of several crocodilian lineages.

Plannthin, D.-K. (2016). Animal Ethics and Welfare in the Fashion and Lifestyle Industries. Pp. 49-122 *in Green Fashion*, Volume 2, ed. by S.S. Muthu and M.A. Gardetti. Part of the series Environmental Footprints and Eco-design of Products and Processes. Springer Science+Business media: Singapore.

Abstract: The purpose of this study is to contribute to the ongoing ethical discussion regarding the use of animals in the fashion and lifestyle industries and to address the attitude and behavioral practices currently being used in the field of animal production and animal welfare. The aim is to investigate, both theoretically and empirically, why it is necessary to apply and implement ethical standards and to address the challenges being faced in how animals are used in these industries. The impact on the environment, a general lack of awareness, and research into ethical consumption will also be explored. By questioning these issues, a better understanding of the contradiction in the ethical production and consumption of animals will emerge. This paper challenges today's decision makers in the fashion and lifestyle industries and argues that despite recent studies in this area, producers, designers, and other decision makers still lack knowledge of what must be addressed to sustain responsible production and consumption practices. The intention is not to write a dissertation on ethics but to attempt to generate interest in the issues that use and take advantage of other living beings, specifically nonhuman animals. The intent is to do this not through negative images, which are otherwise so easily available, but through the prism of impartiality. The goal is to get animal ethics and welfare on the agenda in the fashion and lifestyle industries and to qualify these issues on the same level as human rights and environmental issues. That all decision makers in the future will take responsibility and in turn improve the conditions these animals live in, while supporting the consumption needs of human beings, is the intention and purpose of this chapter.

Burgin, S. and Hardiman, N. (2016). Crocodiles and grey nomads: a deadly combination? Current Issues in Tourism 19(1): 60-63.

Abstract: Increasing numbers of retirees seek individual, extended, unstructured activities in remote, non-commercial locations. Travel is predominantly by self-drive 4WD vehicle towing a caravan/ campervan. These 'grey nomads' often prefer remote bush camping sites/caravan parks to commercial resorts. The tropics - a popular destination - are inhabited by Australia's only large semi-terrestrial carnivore, the estuarine crocodile *Crocodylus porosus*. Conservation programmes of recent decades have resulted in a substantial increase in numbers. With naive grey nomads increasingly encroaching on crocodile territory, attacks are expected to increase. Review of conservation programmes to incorporate awareness education targeting grey nomads is therefore required.

Escobedo-Galvan, A.H., Velasco, J.A., Gonzalez-Maya, J.F. and Resetar, A. (2016). Morphometric analysis of the Rio Apaporis Caiman (Reptilia, Crocodylia, Alligatoridae). Zootaxa 4059(3): 541-554.

Abstract: *Caiman crocodilus apaporiensis* has been considered by several authors as an extreme of morphological variation within the *Caiman crocodilus* complex. Here, we evaluate its position in the *Caiman crocodilus* complex morphospace using morphological traits from head shape. We examined the holotype and seventeen paratypes of *Caiman crocodilus apaporiensis* Medem 1955 deposited at the Field Museum of Natural History. We performed multivariate morphometric analyses: principal component analysis (PCA) and discriminant function analysis (DFA), based on 21 cranial traits of *C. c. apaporiensis*, *C. yacare* and the *C. crocodilus complex* (*C. c. chiapasius*, *C. c. fuscus* and *C. c. crocodilus*). We find a notable separation of *C. c. apaporiensis* from *C. yacare* and *C. crocodilus* complex in the morphospace. We suggest that geographic isolation might have driven this morphological separation from the *C. crocodilus* complex, but further analysis are necessary to confirm whether these differences are related with genetic differentiation within the complex. In addition, we suggest that environmental heterogeneity might drive the evolution of independent lineages within the *C. crocodilus* complex.

Olatunji-Akioye, A. and Otuh, P. (2015). Multiple spinal curvatures in a captive African dwarf crocodile *Osteolaemus tetraspis* (Cope, 1861). Sokoto J. Vet. Sci. 13(3): 56-60.

Abstract: A 4 year old African Dwarf crocodile that had been domiciled at the Zoological Gardens, University of Ibadan for 2 years was presented with a history of anorexia of two weeks' duration and reluctance to move for about a week prior to presentation. Physical examination revealed body curvatures and radiography was requested. Dorsoventral, ventrodorsal and left lateral views were done and these revealed multiple curvatures of the cervical, thoracic and caudal vertebrae. There appeared to be a generalized reduction in bone density although there were no visible fractures. There was a lateral compression of the right lung and a downward displacement of the cardiac silhouette. There were also several mineral opacities within the stomach which are suspected to be stones. Metabolic

Bone Disease is a non-infectious disease common to reptiles in captivity. It is a consequence of improper diet and husbandry. A diet of flesh without bone or calcium supplements can cause an imbalance leading to the signs and symptoms seen. This can also be worsened by lack of, or insufficient, Vitamin D. It has severe effects in young animals as they require a higher nutritional plane to meet growth requirements. It is essential that reptiles in captivity receive calcium supplementation to maintain calcium: phosphorus balance and adequate exposure to sunlight or artificial ultraviolet light to encourage the synthesis of Vitamin D in the skin. These will prevent the production of parathyroid hormone which causes bone resorption and leads to swollen misshapen bones, fractures, twisting of the spine and kidney damage.

Nilsen, F.M., Parrott, B.B., Bowden, J.A., Kasim, B.L., Somerville, S.E., Bryan, T.A., Bryan, C.E., Lange, T.R., Delaney, J.P., Brunell, A.M., Long, S.E. and Guilette, L.J., Jr. (2016). Global DNA methylation loss associated with mercury contamination and aging in the American alligator (*Alligator mississippiensis*). Science of The Total Environment 545-546: 389-397.

Abstract: Mercury is a widespread environmental contaminant with exposures eliciting a well-documented catalog of adverse effects. Yet, knowledge regarding the underlying mechanisms by which mercury exposures are translated into biological effects remains incomplete. DNA methylation is an epigenetic modification that is sensitive to environmental cues, and alterations in DNA methylation at the global level are associated with a variety of diseases. Using a liquid chromatography tandem mass spectrometry-based (LC-MS/MS) approach, global DNA methylation levels were measured in red blood cells of 144 wild American alligators (*Alligator mississippiensis*) from 6 sites with variable levels of mercury contamination across Florida's north-south axis. Variation in mercury concentrations measured in whole blood was highly associated with location, allowing the comparison of global DNA methylation levels across different "treatments" of mercury. Global DNA methylation in alligators across all locations was weakly associated with increased mercury exposure. However, a much more robust relationship was observed in those animals sampled from locations more highly contaminated with mercury. Also, similar to other vertebrates, global DNA methylation appears to decline with age in alligators. The relationship between age-associated loss of global DNA methylation and varying mercury exposures was examined to reveal a potential interaction. These findings demonstrate that global DNA methylation levels are associated with mercury exposure, and give insights into interactions between contaminants, aging, and epigenetics.

Whitaker, N. (2015). Survey techniques for the Marsh or Mugger crocodile (*Crocodylus palustris*: Lesson 1831). Pp. 237-240 *in* Biodiversity and Evaluation: Perspectives and Paradigm Shifts, ed. by S.B. Nandan, S. Kumar S., K.D. Mini and Babu, R. Cusat Cochin University of Science and Technology and Sree Sankara College: Cochin and Kalady.

Abstract: Techniques for the observation of crocodilians in the field vary according to situation, habitat, and season. An imperative survey need for a given population is to gauge size structure, using both direct and indirect techniques, each with their own advantages and disadvantages. With reference to the Indian situation, much of the marsh crocodile population, whether released or already existing, occur in dams, and other catchments. Populations are fragmented, perhaps largely due to the ability of this crocodilian to move long distances overland, their adaptations to high and low temperatures, and release from captive facilities. The following chapter is an attempt to provide researchers with simple but viable options to estimate size, environmental/seasonal variables and how they affect sightings of mugger crocodiles, and required replicability of surveys.

Brock, J.W., Bell, J.M. and Guilette, L.J., Jr. (2016). Urinary phthalate metabolites in American alligators (*Alligator mississippiensis*) from selected Florida wetlands. Archives of Environmental Contamination and Toxicology (10.1007/s00244-015-0260-6).

Abstract: Phthalates have been shown to cause endocrine disruption in laboratory animals and are associated with altered development of the reproductive system in humans. Further, human have significant exposure to phthalates. However, little is known concerning the exposure of wildlife to phthalates. We report urinary phthalate metabolite concentrations from 50 juvenile alligators from three Florida lakes and a site in the Everglades. Urinary phthalate monoester concentrations varied widely among alligators from the different sites but also among alligators from the same site. Mono-2-ethylhexy phthalate and monobutyl phthalate were found in most samples of alligator urine with maximums of 35,700 ng/mL and 193 ng/mL, respectively. Monobenzyl phthalate was found in 5 alligators with a maximum of 66.7 ng/mL. Other monoesters were found in only one or two alligator urine samples. The wide variation within and among sites, in addition to the high levels of mEHP, mBP and mBzP, is consistent with exposure arising from the intermittent spraying of herbicide formulations to control invasive aquatic plants in Florida freshwater sites. Phthalate diesters are used as adjuvants in many of these formulations.

Hamilton, M.T., Finger, J.W., Jr., Winzeler, M.E. and Tuberville, T.D. (2016). Evaluating the effect of sample type on American alligator (*Alligator mississippiensis*) analyte values in a point-of-care blood analyser. Conservation Physiology 4(1) (4 (1): cov065 (doi:10.1093/conphys/cov065).

Abstract: The assessment of wildlife health has been enhanced by the ability of point-of-care (POC) blood analysers to provide biochemical analyses of non-domesticated animals in the field. However, environmental limitations (eg temperature, atmospheric humidity and rain) and lack of reference values may inhibit researchers from using such a device with certain wildlife species. Evaluating the use of alternative sample types, such as plasma, in a POC device may afford researchers the opportunity to delay sample analysis and the ability to use banked samples. In this study, we examined fresh whole blood, fresh plasma and frozen plasma (sample type) pH, partial pressure of carbon dioxide (PCO_2), bicarbonate (HCO_3^-), total carbon dioxide (TCO_2), base excess (BE), partial pressure of oxygen (PO_2), oxygen saturation (sO_2) and lactate concentrations in 23 juvenile American alligators (*Alligator mississippiensis*) using an i-STAT CG4+ cartridge. Our results indicate that sample type had no effect on lactate concentration values ($F_{2,65}$= 0.37, P= 0.963), suggesting that the i-STAT analyser can be used reliably to quantify lactate concentrations in fresh and frozen plasma samples. In contrast, the other seven blood parameters measured by the CG4+ cartridge were significantly affected by sample type. Lastly, we were able to collect blood samples from all alligators within 2 min of capture to establish preliminary reference ranges for juvenile alligators based on values obtained using fresh whole blood.

Arukwe, A., Myburgh, J., Langberg, H.A., Adeogun, A., Braa, I.G., Moeder, M., Schlenk, D., Crago, J.P., Regoli, F. and Bothaa, C. (2016). Developmental alterations and endocrine-disruptive responses in farmed Nile crocodiles (*Crocodylus niloticus*) exposed

to contaminants from the Crocodile River, South Africa. Aquatic Toxicology (doi:10.1016/j.aquatox.2015.12.027).

Abstract: In the present study, the developmental (including fertility) and endocrine-disruptive effects in relation to chemical burden in male and female Nile crocodiles (*Crocodylus niloticus*), from a commercial crocodile farm in the Brits district, South Africa, exposed to various anthropogenic aquatic contaminants from the natural environment was investigated. Hepatic transcript levels for vitellogenin (Vtg), zona pellucida (ZP) and ERα (also in gonads) were analyzed using real-time PCR. Plasma estradiol-17β (E2), testosterone (T) and 11-ketotestosterone (11-KT) were analyzed using enzyme immunoassay. Gonadal aromatase and hepatic testosterone metabolism (6β-hydroxylase (6β-OHase)) were analyzed using biochemical methods. Overall, there is high and abnormal number (%) of infertile and banded eggs during the studied reproductive seasons, showing up to 57 and 34% of infertile eggs in the 2009/2010 and 2013/2014 seasons, respectively. In addition, the percentage of banded eggs ranged between 10-19% during the period of 2009-2014 seasons. While hepatic ERα, Vtg, ZPmRNA and 6β-OHase, were equally expressed in female and male crocodiles, gonadalERα mRNA and aromatase activity were significantly higher in females compared to male crocodiles. On the other hand, plasma T and 11-KT levels were significantly higher in males, compared to female crocodiles. Principal component analysis (PCA) produced significant grouping that revealed correlative relationships between reproductive/endocrine-disruptive variables and liver contaminant burden, that further relates to measured contaminants in the natural environment. The overall results suggest that these captive pre-slaughter farm crocodiles exhibited responses to anthropogenic aquatic contaminants with potentially relevant consequences on key reproductive and endocrine pathways and these responses may be established as relevant species endocrine disruptor biomarkers of exposure and effects in this threatened species.

Akiyoshi, H., Inoue-Matsuo, A. and Onodera, I. (2016). Comparative histological study of parenchymal arrangements in three orders of reptilian livers. J. Phylogen. Evolution Biol. 4: 161. (http://dx.doi.org/10.4172/2329-9002.1000161).

Abstract: This study presented detailed descriptions of parenchymal arrangements in the livers of 23 reptilian species using light microscopy, and extensively discussed this from a phylogenetic viewpoint. Hepatocyte sinusoidal structures (HSS) were classified into three different types: (I) the several-cell-thick plate type, (II) two-cell-thick plate type, and (III) one-cell-thick plate type. Parenchymal arrangements showed either the combined two- and one-cell-thick plate type or one-cell-thick plate type, whereas the sea snake in the sub-order Serpentes showed the several-cell-thick plate type. In the order Testudines, peripheral sinusoids near terminal portal veins were tortuous, becoming straighter toward terminal central veins. Melanomacrophages (MMs) were observed in sinusoidal capillaries in the order Testudinata, Crocodilia, and Squamata, but not in the sub-order Serpentes (except for the sea snake). This study showed that the architecture of the parenchymal arrangement was related to the phylogenetic relationship, whereas the distribution of MMs may not be. The MMs systems of turtles, alligators, and sea snakes, whose place of main habitation is underwater, may have adapted according to ecological and behavioral patterns. Based on the hepatic architecture of parenchymal arrangements and the distribution of MMs, it was suggested that reptilian livers acquired the division of three zones in the acinus.

Ticha, L., Golovchenko, M., Oliver, J.H., Jr., Grubhoffer, L. and Rudenko, N. (2016). Sensitivity of lyme borreliosis spirochetes to serum complement of regular zoo animals: potential reservoir competence of some exotic vertebrates. Vector-Borne and Zoonotic Diseases 16(1): 13-19.

Abstract: Reaction of vertebrate serum complement with different *Borrelia burgdorferi* sensu *lato* species is used as a basis in determining reservoir hosts among domesticated and wild animals. *Borrelia burgdorferi* sensu *stricto*, *Borrelia garinii*, and *Borrelia afzelii* were tested for their sensitivity to sera of exotic vertebrate species housed in five zoos located in the Czech Republic. We confirmed that different *Borrelia* species have different sensitivity to host serum. We found that tolerance to *Borrelia* infection possessed by hosts might differ among individuals of the same genera or species and is not affected by host age or sex. Of all zoo animals included in our study, carnivores demonstrated the highest apparent reservoir competency for Lyme borreliosis spirochetes. We showed that selected exotic ungulate species are tolerant to *Borrelia* infection. For the first time we showed the high tolerance of Siamese crocodile to Borrelia as compared to the other studied reptile species. While exotic vertebrates present a limited risk to the European human population as reservoirs for the causative agents of Lyme borreliosis, cases of incidental spillover infection could lead to successful replication of the pathogens in a new host, changing the status of selected exotic species and their role in pathogen emergence or maintenance. The question if being tolerant to pathogen means to be a competent reservoir host still needs an answer, simply because the majority of exotic animals might never be exposed to spirochetes in their natural environment.

Sujiwattanarat, P., Pongsanarakul, P., Temsiripong, Y., Temsiripong, T., Thawornkuno, C., Uno, Y., Unajak, S., Matsuda, Y., Choowongkomon, K., and Srikulnath, K. (2016). Molecular cloning and characterization of Siamese crocodile (*Crocodylus siamensis*) copper, zinc superoxide dismutase (CSI-Cu,Zn-SOD) gene. Comparative Biochemistry and Physiology Part A 191: 187-195.

Abstract: Superoxide dismutase (SOD, EC 1.15.1.1) is an antioxidant enzyme found in all living cells. It regulates oxidative stress by breaking down superoxide radicals to oxygen and hydrogen peroxide. A gene coding for Cu,Zn-SOD was cloned and characterized from Siamese crocodile (*Crocodylus siamensis*; CSI). The full-length expressed sequence tag (EST) of this Cu,Zn-SOD gene (designated as CSI-Cu,Zn-SOD) contained 462 bp encoding a protein of 154 amino acids without signal peptides, indicated as intracellular CSI-Cu,Zn-SOD. This agreed with the results from the phylogenetic tree, which indicated that CSI-Cu,Zn-SOD belonged to the intracellular Cu,Zn-SOD. Chromosomal location determined that the CSI-Cu,Zn-SOD was localized to the proximal region of the Siamese crocodile chromosome 1p. Several highly conserved motifs, two conserved signature sequences (GFHVHEFGDNT and GNAGGRLACGVI), and conserved amino acid residues for binding copper and zinc (His47, His49, His64, His72, His81, Asp84, and His120) were also identified in CSI-Cu,Zn-SOD. Real-time PCR analysis showed that CSI-Cu,ZnSOD mRNA was expressed in all the tissues examined (liver, pancreas, lung, kidney, heart, and whole blood), which suggests a constitutively expressed gene in these tissues. Expression of the gene in *Escherichia coli* cells followed by purification yielded a recombinant CSI-Cu,Zn-SOD, with Km and Vmax values of 6.075 mM xanthine and 1.4×10^{-3} mmol min^{-1} mg^{-1}, respectively. This Vmax value was 40 times lower than native Cu,Zn-SOD (56×10^{-3} mmol min^{-1} mg^{-1}), extracted from crocodile erythrocytes. This suggests that cofactors, protein folding properties, or post-translational modifications were lost during the protein purification process, leading to a reduction in the rate of enzyme activity in bacterial expression of CSI-Cu,Zn-SOD.

Taylor, P., Li, F., Holland, A., Martin, M. and Rosenblatt, A.E. (2016). Growth rates of black caiman (*Melanosuchus niger*) in the Rupununi region of Guyana. Amphibia-Reptilia (doi: 10.1163/15685381-00003024).

Abstract: We conducted a study of black caiman (*Melanosuchus niger*) growth rates using data from a long-term mark-recapture study carried out in the Rupununi region of Guyana between 2005 and 2015. In contrast to previous studies, growth rates of black caiman declined with increasing size and this decline occurred more rapidly for females. Size-at-age models predicted that males and females reach asymptotic sizes of 178.2-189.0 cm SVL and 140.1-143.4 cm SVL, respectively. Our results suggest that growth rates of black caiman in the Rupununi region follow the same general patterns as for other crocodilians, and that disparities with previous black caiman studies may be largely related to density-dependent factors, among other possibilities. However, future studies that include large black caiman of known ages are needed to validate our findings.

Robinson, R.F., Jasinski, S.E. and Sullivan, R.M. (2015). Theropod bite marks on dinosaur bones: indications of a scavenger, predator or both?; and their taphonomic implications. Pp. 275-282 *in* Fossil Record 4, ed. by R.M., Sullivan and S.G. Lucas. New Mexico Museum of Natural History and Science Bulletin 68.

Abstract: Three nearly complete, isolated vertebrae, and a right humerus of a sub-adult hadrosaurine (Ornithopoda: Hadrosaurinae), all from separate individuals and from the Late Cretaceous (late Campanian) Hunter Wash local fauna (Fruitland Formation [Fossil Forest Member] and Kirtland Formation [Hunter Wash Member]), San Juan Basin, New Mexico, bear distinctive bite marks. These bite marks vary in size and shape, suggesting that different species of theropods, or possibly different ontogenetic individuals of a single species, were feeding on the carcasses pertaining to these individual elements. The isolated vertebrae suggest post-mortem bites, probably from scavenging behavior, whereas the bite marks on the humerus may have been inflicted during predation. Based on the bite mark traces, it appears that all bite marks were made by tyrannosauroids of different ontogenetic stages and/or different species.

Borges, R.M., Pressinotti, L.N., Aleixo, V.M., Borges, J.C.S., Bergamo, A.S., Iunes, R.S. and Da Silva, J.R.M.C. (2016). Dietary lipid absorption and lipoprotein secretion by the intestine of the crocodilian Caiman yacare (Daudin, 1802). Zoomorphology (doi:10.1007/s00435-015-0300-9).

Abstract: Although it is stated that dietary lipids are absorbed proximally in the small intestine of vertebrates, there are variations of the primary site for lipid absorption even when closely related species are considered. Moreover, there are evidences suggesting that the small intestine distal segments are equally capable of absorbing lipids, although it is not known whether it is the case for crocodilians. The lipoprotein assembling process and secretion routes are also largely unknown for crocodilians and therefore, assumed to be similar to mammals. The aims of this study were to identify the crocodilian Caiman yacare intestinal segments where lipid absorption occurs, to characterize the intestinal lipoproteins secreted by enterocytes and to evaluate lymphatic system contribution to exportation of lipoproteins from the intestine. For this, soybean oil was injected into C. yacare stomach and intestinal lipid absorption process was characterized by light and electron microscopy 24, 48 and 72 h after oil injection. The same amount of lipid inclusions was present in the duodenum, in the proximal jejunum and in the distal jejunum. The colon also showed a few lipid inclusions. The bulk of lipoproteins secreted by the enterocytes was <200 nm in diameter and was observed inside the lymphatic central lacteals. Lipid inclusions were absent from the intestinal mucosa and from the lacteals of the control animals. Finally, the high amount of lipids ingested did not recruit innate immune cells to the mucosa in any intestinal segment, suggesting that soybean oil is not pro-inflammatory for intestinal mucosa of C. yacare in the short time analyzed.

Musser, J., Wagner, G.P. and Prum, R.O. (2015). Nuclear β-catenin localization supports homology of feathers, avian scutate scales, and alligator scales in early development: Feather and scale developmental homology Evolution & Development 17(3): 185-94.

Abstract: Feathers are an evolutionary novelty found in all extant birds. Despite recent progress investigating feather development and a revolution in dinosaur paleontology, the relationship of feathers to other amniote skin appendages, particularly reptile scales, remains unclear. Disagreement arises primarily from the observation that feathers and avian scutate scales exhibit an anatomical placode-defined as an epidermal thickening-in early development, whereas alligator and other avian scales do not. To investigate the homology of feathers and archosaur scales we examined patterns of nuclear β-catenin localization during early development of feathers and different bird and alligator scales. In birds, nuclear β-catenin is first localized to the feather placode, and then exhibits a dynamic pattern of localization in both epidermis and dermis of the feather bud. We found that asymmetric avian scutate scales and alligator scales share similar patterns of nuclear β-catenin localization with feathers. This supports the hypothesis that feathers, scutate scales, and alligator scales are homologous during early developmental stages, and are derived from early developmental stages of an asymmetric scale present in the archosaur ancestor. Furthermore, given that the earliest stage of β-catenin localization in feathers and archosaur scales is also found in placodes of several mammalian skin appendages, including hair and mammary glands, we hypothesize that a common skin appendage placode originated in the common ancestor of all amniotes. We suggest a skin placode should not be defined by anatomical features, but as a local, organized molecular signaling center from which an epidermal appendage develops.

Zhang, J.-X., Song, R., Sang, M., Sun, S.-Q., Ma, L., Zhang, J. Zhang, S.-Q. (2015). Molecular and functional characterization of BAFF from the Yangtze alligator (*Alligator sinensis*, Alligatoridae). Zoology 118(5): 325-333.

Abstract: B-cell activating factor (BAFF) from the TNF family is critical for B-cell survival and maturation. In this study, we identified a Yangtze alligator (*Alligator sinensis*, Alligatoridae) BAFF cDNA, designated as asBAFF, using reverse transcription polymerase chain reaction (RT-PCR) and rapid amplification of cDNA ends (RACE). The open reading frame of this cDNA encodes a 287-amino acid protein containing a predicted transmembrane domain and a furin protease cleavage site, similar to mammalian and avian BAFF. The amino acid identity between biologically soluble asBAFF (assBAFF) and csBAFF, hsBAFF, and msBAFF is 94, 76, and 71%, respectively. Real-time quantitative PCR analysis showed that the asBAFF gene is strongly expressed in the spleen. Since BAFF is always expressed as inclusion bodies in bacteria, it is difficult to purify. To enhance the soluble expression of assBAFF in *Escherichia coli*, we fused the extracellular region of the asBAFF gene to a small ubiquitin-related modifier gene (SUMO). Purified assBAFF was able to promote the survival of splenic lymphocytes and co-stimulate the proliferation of mouse B cells with anti-mouse

IgM. These findings suggest that asBAFF plays an important role in the survival and proliferation of Yangtze alligator B cells, and because it is evolutionarily highly conserved, functional cross-reactivity exists between mammalian and Yangtze alligator BAFF.

Zhao, J., Wang, S., Tu, G., Zhou, Y., Wu, X. and Li, C. (2015). Histopathology of gastric wall in Chinese alligator *Alligator sinensis* infected with *Ortleppascaris sinensis* (Nematoda: Ascaridoidea). Nutr. Hosp. 32: 1180-1183.

Abstract: Crocodiles are susceptible to infection with a wide array of external and internal gastrointestinal helminths, yet little is known on the histopathology following infection or the effects of these parasites. The present study was aimed at evaluating the impact of infection by *Ortleppascaris sinensis* (Nematoda: Ascaridoidea) on the stomach of captive *Alligator sinensis*. The histological examination of the stomach revealed presence of superficial ulcer in mucous layer and granulomatous inflammation in submucous layer at entire gastric walls of the *Alligator sinensis*. Our findings also confirm that development of *Ortleppascaris sinensis* is in close association with the wall of the stomach.

Georgi, J., Jacofsky, M. and Manfredi, K. (2015). The first prosthetic alligator tail and the role of the tail in normal terrestrial locomotion. The FASEB Journal 29(1): Supplement 865, 14.

Abstract: An American alligator (*Alligator mississippiensis*) after losing all but the most proximal tail exhibits abnormal walking. Here we report the extent to which normal locomotion is restored with a first of its kind prosthetic replacement tail. The caudofemoralis muscles are intact and able to retract the pelvic limbs normally. It is, therefore, likely that deviations from normal result instead from a cranially-displaced center of mass and imbalance of typical forces due to the absence of drag from the distal tail. Thus, we expect that being fitted with a passive prosthetic tail of appropriate size and mass will restore a more natural and orthopedically correct walk. 3D kinematic data show that, without a tail, strides are shorter ($p<<0.001$) and slower ($p<<0.001$) than expected for an alligator of similar skeletal size. In addition, lateral undulations of the pelvic girdle are exaggerated ($p<<0.001$). Walking posture is also altered and results in a pelvis that is higher ($p<<0.001$) and a pes placement that is wider ($p << 0.001$) than in other alligators. With the prosthesis, there is no change in pelvic lateral movement ($p= 0.184$) but there are significant changes in stride length ($p <<0.001$), stride duration ($p= 0.009$), and pelvis height ($p <<0.001$) as all return to the expected range. Pes placement narrows ($p= 0.004$), although it is still wider than normal ($p<<0.001$). Aspects of walking linked to posture and balance are improved or completely restored with the prosthesis, but learned behaviors such as excessive lateral undulation are not immediately impacted but are expected to improve over time. This work is supported by Midwestern University and The CORE Institute.

Elsey, R.M. and Trosclair, P.L., III. (2016). The use of an unmanned aerial vehicle to locate alligator nests. Southeastern Naturalist 15(1): 76-82.

Abstract: Coastal marshes of Louisiana provide nesting habitat for *Alligator mississippiensis* (American Alligator). Helicopters are typically used to locate alligator nests in remote interior marshes. We tested the use of an unmanned aerial vehicle (UAV) to detect alligator nests on Rockefeller Wildlife Refuge in Grand Chenier, LA. Three brief flights with a combined search time of approximately 25 minutes and 9 seconds were conducted in a single afternoon, covering 28.2 ha. While in the field, we observed 6 alligator nests with the UAV, and later review of video imagery recorded allowed us to detect an additional 6 alligator nests. The use of UAVs may be a useful tool for detecting alligator nests.

Finger, J.W., Thomson, P.C. and Isberg, S.R. (2016). Unexpected lower testosterone in faster growing farmed saltwater crocodile (*Crocodylus porosus*) hatchlings. General and Comparative Endocrinology 226: 1-4.

Abstract: Agricultural production of the saltwater crocodile (*Crocodylus porosus*) is an emergent industry in northern Australia with many of the factors affecting production remaining unknown. In this study, we sought to expand upon our previous findings of reference corticosterone and immune function by reporting baseline sex hormone levels [testosterone (TEST) and estradiol (ESTR)] and their association with growth. This was achieved by sampling 253 hatchling crocodiles repeatedly at 3, 6, and 9 months of age. Sampling age had a significant effect on both TEST ($p<0.001$) and ESTR ($p<0.001$) suggesting climatic/abiotic factors have an influence even in prepubescent crocodiles. Stress, as measured by plasma corticosterone, had no detectable effect on plasma ESTR or TEST levels. Unexpectedly however, TEST was higher in slower-growing crocodiles, which is contrary to what has been reported for the American alligator. ESTR was not associated with growth.

Machado-Santos, C., de S. Santana, L.N., Vargas, R.F., Abidu-Figueiredo, M., De Brito-Gitirana, L. and Chagas, M.A. (2016). Histological and immunohistochemical study of the ovaries and oviducts of the juvenile female of *Caiman latirostris* (Crocodilia: Alligatoridae). Zoologia 32(5): 395-402.

Abstract: The purpose of this study was to examine the ovaries and the oviduct of juvenile females of the broad-snouted caiman, *Caiman latirostris* (Daudin, 1802), using light microscopy, histochemical and immunocytochemical techniques. The ovarian cortex was observed to contain groups of germinative cells and abundant previtellogenic follicles at different stages of development. In previtellogenic follicles, the oocyte was surrounded by a single cuboidal layer of granulosa cells, supported by the theca layer. The theca was formed by a concentric layer containing collage nous fibers, predominantly type I, and several smooth muscle fibers. The inner perivitelline layer appeared as a narrow basophilic region between the oocyte and the granulosa. The ovarian medullary region of loose connective tissue contained blood and lymphatic vessels, as well as numerous lacunae, being covered by a simple squamous epithelium, supported by a thin layer of connective tissue. The oviduct of *C. latirostris* showed five histologically distinct regions: infundibulum, magnum, isthmus, uterus and vagina. The infundibulum was composed of an irregularly folded mucosa covered by a simple columnar epithelium with the presence of ciliated cells, weakly reactive to PAS staining. In the magnum, the mucosa was highly folded, and pseudostratified columnar epithelium contains mucous cells, which reacted positively to PAS staining. The isthmus was lining by an epithelium of ciliated and non-ciliated secretory cells, but no gland was visualized in mucosa. In the uterus, the folded mucosa was composed of a simple epithelium of high cylindrical cells and the lamina propria, which was predominantly formed by strongly birefringent fibers, but yellow-green weakly birefringent fibers were also present. The epithelium of the vagina contained intensely ciliated and non-ciliated cells, both of which were positive to PAS staining and no gland was observed in this region. Although the ovary and the oviduct showed some morphological particularities, they are similar to other crocodilians.

Murray, C.M. (2015). The Interface of Population Dynamics, Endocrine-Disrupting Compounds and Enigmatic Disturbance: Understanding Human-Crocodile Conflict in Costa Rica. PhD thesis, Auburn University, Auburn, Alabama, USA.

Abstract: A recent survey indicates a unique male-biased sex ratio in a prized ecotourism species and aquatic sentinel taxon, the American crocodile (*Crocodylus acutus*), at Palo Verde National Park, an influential conservation area in northeastern Costa Rica. Palo Verde harbors an extensive ephemeral marsh that serves as a critical migratory-bird pathway and is home to multiple species of conservation concern in tropical dry forest habitat. Human conflict with this species heightens as the distributions of humans and crocodiles increasingly overlap in this region and media exposure of crocodile attacks becomes more widespread. Here, I test the presence of a male-biased sex ratio among crocodile age cohorts at Palo Verde and assess sex- specific immigration and emigration within these cohorts. Further, I test two hypotheses in an attempt to explain the male-biased sex ratio. First, I test the presence and effect of regional warming, as a result of global climate change, on sex determination within crocodile eggs, as well as potential compensatory nesting behaviors that may influence crocodile sex determination at the level of nest microhabitat. Second, the efficacy of a synthetic androgen used in local tilapia farming (17α-methyltestosterone, MT) to bias sexual differentiation towards males is tested. Exposure of crocodiles to this synthetic hormone is tested in natural populations of crocodiles and the role of MT as an environmental androgen is assessed in American alligators, a surrogate for the effect of this chemical on crocodiles. Demographic analysis indicates a 2:1 male-biased sex ratio in adults that results from balance migration of females and a net pattern of emigration of sub-adult males from a 4:1 male-biased sex ratio at hatching. Analysis of nest temperatures predicts a female bias in hatchling sex ratio based on nest thermal regimes, a pattern inconsistent with the observed male-biased sex ratio for the hatchling cohort. However, my data show a strong influence of metabolic heating on nest temperatures, a feature previously unknown for American crocodiles. Exposure of American alligator eggs to MT and female-producing temperatures results in hatchlings of both sexes including hermaphroditic individuals. Finally, sampling of the natural population of American crocodiles reveals the presence of MT in egg yolk, hatchling, juvenile and adult blood plasma in all sampling localities. These results indicate that MT is a potent environmental androgen capable of causing the male-biased sex ratio in the Tempisque River basin and other nearby drainages.

Boggs, A.S.P., Hamlin, H.J., Nifong, J.C., Kassim, B.L., Lowers, R.H., Galligan, T.M., Long, S.E. and Guilette, L.J., Jr. (2016). Urinary iodine and stable isotope analysis to examine habitat influences on thyroid hormones among coastal dwelling American alligators. General and Comparative Endocrinology 226: 5-13.

Abstract: The American alligator, generally a freshwater species, is known to forage in marine environments despite the lack of a salt secreting gland found in other crocodylids. Estuarine and marine foraging could lead to increased dietary uptake of iodine, a nutrient necessary for the production of thyroid hormones. To explore the influence of dietary iodine on thyroid hormone health of coastal dwelling alligators, we described the seasonal plasma thyroxine and triiodothyronine concentrations measured by radioimmunoassay and urinary iodine (UI) concentrations measured by inductively coupled plasma mass spectrometry. We also analyzed long-term dietary patterns through stable isotope analysis of scute tissue. Snout-to-vent length (SVL) was a significant factor among UI and stable isotope analyses. Large adult males greater than 135 cm SVL had the highest UI concentrations but did not display seasonality of thyroid hormones. Alligators under 135 SVL exhibited seasonality in thyroid hormones and a positive relationship between UI and triiodothyronine concentrations. Isotopic signatures provided supporting evidence that large males predominantly feed on marine/estuarine prey whereas females showed reliance on freshwater/terrestrial prey supplemented by marine/estuarine prey. UI measurement provided immediate information that correlated to thyroid hormone concentrations whereas stable isotope analysis described long-term dietary patterns. Both techniques demonstrate that adult alligators in coastal environments are utilizing estuarine/marine habitats, which could alter thyroid hormone physiology.

Hibbitts, T.D. and Hibbitts, T.L. (2016). Texas Turtles and Crocodilians - A Field Guide. University of Texas Press: Austin, Texas.

Ruske, B. (2015). Alligator Articulation. The ASHA Leader 20: 12. (doi:10.1044/leader.GL.20122015.12).

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: 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.

Hadri, M., Boutakiout, M., Gómez, F. and Pérez-Lorente, F. (2015). Crocodyliform footprints from “les couches rouges” of the Middle Jurassic of Msemrir, High Atlas, Morocco. Geogaceta, 58: 43-46.

Abstract: Two Crocodyliform footprints from “les couches rouges” of the Middle Jurassic of the High Atlas are described.We highlight it for its scarcity in the global record. Footprints cannot be compared with other known ichnogenus. The pes print is incomplete.We assume that it is a continental crocodyliform because the footprints are in fluvial deposits. Finally there follows, although with wide margins of uncertainty, the size that we assume for the trackmaker.

Fernandez, L.M., Aria, M. and Khazan, E.S. (2015). Analysis of

population density and distribution of Spectacled caiman (*Caiman crocodilus*) on Caño Palma, northeast Costa Rica. Herpetological Conservation and Biology 10(3): 959-968.

Abstract: In nearly all ecosystems, top predators play a key role, influencing communities by driving top down effects. The Spectacled Caiman (*Caiman crocodilus*), one of two species of crocodilians in Costa Rica, plays this role in many Neotropical rivers. As a long-lived top predator, it can be used as environmental sentinel to help assess ecosystem conditions of inhabited areas. Here, we assess the population size of *C. crocodilus* in a canal in Northeast Costa Rica and the distribution and clustering of age classes throughout the canal. We conducted weekly surveys between May 2012 and April 2015. We estimated the relative age of the caimans as either juvenile, sub-adult, adult, or eyes only, and we recorded GPS coordinates for each individual. We estimated the total population size using the visible fraction (VF) method. The overall VF was 45.09% and the population was estimated at 32.39 caimans (6.48 caimans/km). The abundance of juveniles decreased over the study period while sub-adults and adults increased over time. Local Moran's I and Hot-Spot analyses demonstrated that caimans are clustered within the canal with juveniles showing the highest levels of clustering in discrete areas, followed by adults. This study provides a population estimation which can serve as a baseline for continued monitoring efforts and to detect long-term changes in density and age demographics of the Spectacled Caiman population of Caño Palma.

Wang, K. and Zhao, H. (2015). Birds generally carry a small repertoire of bitter taste receptor genes. Genome Biology and Evolution (doi:10.1093/gbe/evv180).

Abstract: As they belong to the most species-rich class of tetrapod vertebrates, birds have long been believed to possess an inferior taste system. However, the bitter taste is fundamental in birds to recognize dietary toxins (which are typically bitter) in potential food sources. To characterize the evolution of avian bitter taste receptor genes (Tas2rs) and to test whether dietary toxins have shaped the repertoire size of avian Tas2rs, we examined 48 genomes representing all but three avian orders. The total number of Tas2r genes was found to range from 1 in the domestic pigeon to 12 in the bar-tailed trogon, with an average of 4, which suggested that a much smaller Tas2r gene repertoire exists in birds than in other vertebrates. Furthermore, we uncovered a positive correlation between the number of putatively functional Tas2rs and the abundance of potential toxins in avian diets. Because plant products contain more toxins than animal tissues and insects release poisonous defensive secretions, we hypothesized that herbivorous and insectivorous birds may demand more functional Tas2rs than carnivorous birds feeding on non-insect animals. Our analyses appear to support this hypothesis and highlight the critical role of taste perception in birds.

Hartsell, S.C. and Madsen, T.E. (2012). Non-Snake Reptile Bites. Chapter 141 in Emergency Medicine, ed. by J.G. Adams.

Amavet, P.S., Rueda, E.C., Siroski, P.A., Larriera, A. and Saidman, B.O. (2015). Isolation and characterization of new microsatellite markers for application in population genetic studies of *Caiman latirostris* and related species. Amphibia-Reptilia 36: 175-180.

Abstract: Wild populations of *Caiman latirostris* are subject to sustainable use programs in Argentina, becoming a species with important impact in the regional economy, based in their skin and meat. Genetic studies are fundamental to acquire information on important parameters for conservation and management, which may be obtained from analysis of molecular markers. Some microsatellites have been previously isolated in this species, but due to some difficulties in using them, we obtained new ones using Next Generation Sequencing approach. This study reports 8 new microsatellites for *C. latirostris* and tests their utility in a related species, *Caiman yacare*, with successful application in population genetics and mating systems studies. In addition, we shared data about a novel and fast bioinformatics tool to find microsatellites and to design their corresponding primers.

Klein, H., Milàn, J., Clemmensen, L.B., Frobøse, N., Mateus, O., Klein, N., Adolfssen, J.S., Estrup, E.J. and Wings, O. (2016). Archosaur footprints (cf. *Brachychirotherium*) with unusual morphology from the Upper Triassic Fleming Fjord Formation (Norian-Rhaetian) of East Greenland. Geology and Archaeology: Submerged Landscapes of the Continental Shelf (doi: 10.1144/SP434.1).

Abstract: The Ørsted Dal Member of the Upper Triassic Fleming Fjord Formation in East Greenland is well known for its rich vertebrate fauna, represented by numerous specimens of both body and ichnofossils. In particular, the footprints of theropod dinosaurs have been described. Recently, an international expedition discovered several slabs with 100 small chirotheriid pes and manus imprints (pes length 4-4.5 cm) in siliciclastic deposits of this unit. They show strong similarities with *Brachychirotherium*, a characteristic Upper Triassic ichnogenus with a global distribution. A peculiar feature in the Fleming Fjord specimens is the lack of a fifth digit, even in more deeply impressed imprints. Therefore, the specimens are assigned here tentatively to cf. *Brachychirotherium*. Possibly, this characteristic is related to the extremely small size and early ontogenetic stage of the trackmaker. The record from Greenland is the first evidence of this morphotype from the Fleming Fjord Formation. Candidate trackmakers are crocodylian stem group archosaurs; however, a distinct correlation with known osteological taxa from this unit is not currently possible. While the occurrence of sauropodomorph plateosaurs in the bone record links the Greenland assemblage more closer to that from the Germanic Basin of central Europe, here the described footprints suggest a Pangaea-wide exchange.

Vandewege, M.W., Mangum, S.F., Gabaldón, T., Castoe, T.A., Ray, D.A. and Hoffmann, F.G. (2016). Contrasting patterns of evolutionary diversification in the olfactory repertoires of reptile and bird genomes. Genome Biology and Evolution 9 (doi:10.1093/gbe/evw013).

Abstract: Olfactory receptors (ORs) are membrane proteins that mediate the detection of odorants in the environment, and are the largest vertebrate gene family. Comparative studies of mammalian genomes indicate that OR repertoires vary widely, even between closely related lineages, as a consequence of frequent OR gains and losses. Several studies also suggest that mammalian OR repertoires are influenced by life history traits. Sauropsida is a diverse group of vertebrates group that is the sister group to mammals, and includes birds, testudines, squamates and crocodilians, and represents a natural system to explore predictions derived from mammalian studies. In this study, we analyzed OR repertoire variation among several representative species and found that the number of intact OR genes in sauropsid genomes analyzed ranged over an order of magnitude, from 108 in the green anole to over 1000 in turtles. Our results suggest that different sauropsid lineages have highly divergent OR repertoire composition that derive from lineage-specific combinations of gene expansions, losses, and retentions of ancestral OR genes. These differences also suggest that varying

degrees of adaption related to life history have shaped the unique OR repertoires observed across sauropsid lineages.

Stone, A.K. (2015). Interaction between the Antimicrobial Peptide Leucrocin and Model Membrane Systems. MSc thesis, Tennessee State University.

Abstract: This research project examines leucrocin -specifically leucrocin I - a novel antimicrobial peptide found in the leukocytes of the Siamese crocodile (*Crocodylus siamensis*) and the American alligator (*Alligator mississippiensis*), selected for its unique and highly effective disease-fighting properties. Very few studies have been devoted to the interactions between leucrocin and model membranes. This project focuses on the interactions between leucrocin and selected model membranes using infrared, thermogravimetric analysis (TGA), differential scanning calorimetry (DSC), dynamic light scattering (DLS) and Fluorescence techniques. The results from IR show a strong interaction between leucrocin and model membranes occurs through a change in conformation (except for cholesterol) and the involvement of the carbonyl, phosphate, acyl chains and ammonium groups. The strongest interaction is found in the presence of the DPPC/DOPC/cholesterol (DDCH) complex. DSC data shows that the heat required to break LEU-DDCH is greater than that required to break DDCH. Leucrocin stabilizes the model membrane DDCH. LEU-CHOL is also stable. DLS revealed that leucrocin is a very powerful AMP able to disrupt a model membrane with a very low concentration. Fluorescene provides evidence that the tyrosine residue of leucrocin is one of the probable binding sites for DDCH. The combined investigation of the structure of leucrocin by infrared and its stability by TGA and DSC led to the conclusion that the aggregation of leucrocin in the presence of model membranes is the result of the structural change, rather than purely a change in electrostatic interactions. It was also found that the thermal stability of cardiolipin, DDCH and cholesterol is increased in the presence of leucrocin. The correlations observed in these studies between the nature of the model membranes on the structure of antimicrobial peptide and their biophysical interactions, illustrates the significance of such studies in predicting interactions of antimicrobial peptides with cells.

Hyndman, T.H., Shilton, C.M., Wellehan, Jr., J.F.X., Davis, S., Isberg, S.R., Phalen, D. and Melville, L. (2015). Molecular identification of three novel herpesviruses found in Australian farmed saltwater crocodiles (*Crocodylus porosus*) and Australian captive freshwater crocodiles (*Crocodylus johnstoni*). Veterinary Microbiology (doi:10.1016/j.vetmic.2015.09.013).

Abstract: As part of a larger investigation into three emerging disease syndromes highlighted by conjunctivitis and pharyngitis, systemic lymphoid proliferation and encephalitis, and lymphonodular skin infiltrates in farmed saltwater crocodiles (*Crocodylus porosus*) and one emerging syndrome of systemic lymphoid proliferation in captive freshwater crocodiles (*C. johnstoni*), cytopathic effects (CPE), including syncytial cell formation, were observed in primary crocodile cell lines exposed to clarified tissue homogenates from affected crocodiles. Ten cell cultures with CPE were then screened for herpesviruses using two broadly-reactive herpesvirus PCRs. Amplicons were obtained from 9 of 10 cell cultures and were sequenced. Three novel herpesviruses were discovered and the phylogenetic analysis of these viruses showed there was a 63% Bayesian posterior probability value supporting these viruses clustering with the subfamily Alphaherpesvirinae, and 100% posterior probability of clustering with a clade containing the Alphaherpesvirinae and other unassigned reptile herpesviruses. It is proposed that they are named Crocodyline herpesvirus (CrHV) 1, 2 and 3. CrHV1 and 2 were only isolated from saltwater crocodiles and CrHV3 was only isolated from freshwater crocodiles. A duplex PCR was designed that was able to detect these herpesviruses in formalin-fixed paraffin-embedded tissues, a sample type that neither of the broadly-reactive PCRs was able to detect these herpesviruses in. This work describes the isolation, molecular detection and phylogeny of these novel herpesviruses but the association that they have with the emerging disease syndromes requires further investigation.

Dunbar, J.P., Zarelli, M., Martin, S.A., Gandola, R., Kavanagh, K.A., Walsh, F.M. and Rivas, J.A. (2015). Trunk vertebrae osteomyelitis in a spectacled caiman (*Caiman crocodilus*). The Herpetological Bulletin 134: 15-18.

Abstract: Osteomyelitis is frequently reported in turtles, lizards and snakes and Salmonellae are increasingly reported as the causative organism. However, very little is known of this disease occurring in crocodilians. Crocodilians are shy, robust animals and often hide clinical symptoms, especially when submerged in water. Knowledge of disease in crocodilians is important, especially in zoos and farms where they are often kept in high densities. Here we report the first known case of trunk vertebrae osteomyelitis in the order Crocodilia. A 6-year-old, captive-raised spectacled caiman (*Caiman crocodilus*) was admitted for veterinary examination after developing a postural abnormality in the vertebral region, including spinal curvature and dorsal indentation. Radiographic and Computed Tomographic studies showed muscle wastage and multifocal vertebral osteolytic changes suggestive of osteomyelitis. The caiman was euthanized and post-mortem examination revealed coelomic serosanguinous effusion and a diffuse severe fibrinous coelomitis with firm visceral adhesions involving the liver and spleen. A 15 cm irregular mass was found within and greatly expanding a major blood vessel ventral to the trunk vertebrae. Examination of the mass revealed an organized thrombus and examination of the affected trunk vertebrae revealed severe osteolytic changes with extensive remodeling. *Salmonella enterica houtenae* was isolated from the vertebral lesions. Salmonellae, a common constituent of the reptilian gut microbiota, are potentially pathogenic and can become clinically important in times of stress. *Salmonella enterica houtenae* was previously isolated from reptiles and humans with pathological symptoms. However, this appears to be the first documented case in association with osteomyelitis in vertebrates.

Ngwenya, A., Patzke, N., Manger, P.R. and Herculano-Houzel S. (2016). Continued growth of the central nervous system without mandatory addition of neurons in the Nile crocodile (*Crocodylus niloticus*). Brain Behav. Evol. (doi:10.1159/000443201).

Abstract: It is generally believed that animals with larger bodies require larger brains, composed of more neurons. Across mammalian species, there is a correlation between body mass and the number of brain neurons, albeit with low allometric exponents. If larger bodies imperatively require more neurons to operate them, then such an increase in the number of neurons should be detected across individuals of a continuously growing species, such as the Nile crocodile. In the current study we use the isotropic fractionator method of cell counting to determine how the number of neurons and non-neurons in 6 specific brain regions and the spinal cord change with increasing body mass in the Nile crocodile. The central nervous system (CNS) structures examined all increase in mass as a function of body mass, with allometric exponents of around 0.2, except for the spinal cord, which increases with an exponent of 0.6. We find that numbers of non-neurons increase slowly, but significantly, in all CNS structures, scaling as a function of body mass with exponents

ranging between 0.1 and 0.3. In contrast, numbers of neurons scale with body mass in the spinal cord, olfactory bulb, cerebellum and telencephalon, with exponents of between 0.08 and 0.20, but not in the brainstem and diencephalon, the brain structures that receive inputs and send outputs to the growing body. Densities of both neurons and non-neurons decrease with increasing body mass. These results indicate that increasing body mass with growth in the Nile crocodile is associated with a general addition of non-neurons and increasing cell size throughout CNS structures, but is only associated with an addition of neurons in some structures (and at very small rates) and not in those brain structures directly connected to the body. Larger bodies thus do not imperatively require more neurons to operate them.

Rossi Lafferriere N.A., Antelo, R., Alda, F., Mårtensson, D., Hailer, F., Castroviejo-Fisher, S., Ayarzagüena, J., Ginsberg, J.R., Castroviejo, J., Doadrio, I., Vilá, C. and Amato, G. (2016). Multiple paternity in a reintroduced population of the Orinoco crocodile (*Crocodylus intermedius*) at the El Frío Biological Station, Venezuela. PLoS ONE 11(3): e0150245.

Abstract: The success of a reintroduction program is determined by the ability of individuals to reproduce and thrive. Hence, an understanding of the mating system and breeding strategies of reintroduced species can be critical to the success, evaluation and effective management of reintroduction programs. As one of the most threatened crocodile species in the world, the Orinoco crocodile (*Crocodylus intermedius*) has been reduced to only a few wild populations in the Llanos of Venezuela and Colombia. One of these populations was founded by reintroduction at Caño Macanillal and La Ramera lagoon within the El Frío Biological Station, Venezuela. Twenty egg clutches of *C. intermedius* were collected at the El Frío Biological Station for incubation in the lab and release of juveniles after one year. Analyzing 17 polymorphic microsatellite loci from 335 hatchlings we found multiple paternity in *C. intermedius*, with half of the 20 clutches fathered by two or three males. Sixteen mothers and 14 fathers were inferred by reconstruction of multilocus parental genotypes. Our findings showed skewed paternal contributions to multiple-sired clutches in four of the clutches (40%), leading to an overall unequal contribution of offspring among fathers with six of the 14 inferred males fathering 90% of the total offspring, and three of those six males fathering more than 70% of the total offspring. Our results provide the first evidence of multiple paternity occurring in the Orinoco crocodile and confirm the success of reintroduction efforts of this critically endangered species in the El Frío Biological Station, Venezuela.

Anzola, L.F. and Antelo, R. (2015). First data of natural recovery of any Orinoco crocodile *Crocodylus intermedius* population: Evidence from nesting. The Herpetological Bulletin 134: 10-14.

Abstract: Since the end of commercial hunting in the 1960s, there were no signs of recovery of the Orinoco crocodile (*Crocodylus intermedius*) populations throughout its range. In this study, nest counts have been used to establish population trends in the Arauca Department, Colombia. From December 2014 to April 2015, we surveyed 166.7 km of rivers for nests. Twenty-four nests were located, 2.2 times more than recorded 13 years previously. Our results indicate that *C. intermedius* populations in the area are increasing. The awareness of local people, a reduction in fishing activities and use of the river for transport may explain the recovery.

Antelo, R. and Moorwood, A. (2015). *Crocodylus intermedius* (Orinoco Crocodile). Parental behavior. Herpetological Review 46(2): 206-207.

Gress, J., da Silva, E.B., de Oliveira, L.M., Zhao, D., Anderson, G., Heard, D., Stuchal, L.D. and Ma, L.Q. (2016). Potential arsenic exposures in 25 species of zoo animals living in CCA-wood enclosures. Science of The Total Environment 551-552: 614-621.

Abstract: Animal enclosures are often constructed from wood treated with the pesticide chromated copper arsenate (CCA), which leaches arsenic (As) into adjacent soil during normal weathering. This study evaluated potential pathways of As exposure in 25 species of zoo animals living in CCA-wood enclosures. We analyzed As speciation in complete animal foods, dislodgeable As from CCA-wood, and As levels in enclosure soils, as well as As levels in biomarkers of 9 species of crocodilians (eggs), 4 species of birds (feathers), 1 primate species (hair), and 1 porcupine species (quills). Elevated soil As in samples from 17 enclosures was observed at 1.0-110 mg/kg, and enclosures housing threatened and endangered species had As levels higher than USEPA's risk-based Eco-SSL for birds and mammals of 43 and 46 mg/kg. Wipe samples of CCA-wood on which primates sit had dislodgeable As residues of 4.6-111 μg/100 cm^2, typical of unsealed CCA-wood. Inorganic As doses from animal foods were estimated at 0.22-7.8 μg/kg bw/d. Some As levels in bird feathers and crocodilian eggs were higher than prior studies on wild species. However, hair from marmosets had 6.37 mg/kg As, 30-fold greater than the reference value, possibly due to their inability to methylate inorganic As. Our data suggested that elevated As in soils and dislodgeable As from CCA-wood could be important sources of As exposure for zoo animals.

Cadena, E. (2016). Microscopical and elemental FESEM and Phenom ProX-SEM-EDS analysis of osteocyte- and blood vessel-like microstructures obtained from fossil vertebrates of the Eocene Messel Pit, Germany. PeerJ 4:e1618 (doi: 10.7717/peerj.1618).

Abstract: The Eocene (~48 Ma) Messel Pit in Germany is a UNESCO World Heritage Site because of its exceptionally preserved fossils, including vertebrates, invertebrates, and plants. Messel fossil vertebrates are typically characterized by their articulated state, and in some cases the skin, hair, feathers, scales and stomach contents are also preserved. Despite the exceptional macroscopic preservation of Messel fossil vertebrates, the microstructural aspect of these fossils has been poorly explored. In particular, soft tissue structures such as hair or feathers have not been chemically analyzed, nor have bone microstructures. I report here the preservation and recovery of osteocyte-like and blood vessel-like microstructures from the bone of Messel Pit specimens, including the turtles *Allaeochelys crassesculpta* and *Neochelys franzeni*, the crocodile *Diplocynodon darwini*, and the pangolin *Eomanis krebsi*. I used a Field Emission Scanning Electron Microscope (FESEM) and a Phenom ProX desktop scanning electron microscope (LOT-QuantumDesign) equipped with a thermionic CeB6 source and a high sensitivity multi-mode backscatter electron (BSE) for microscopical and elemental characterization of these bone microstructures. Osteocyte-like and blood vessel-like microstructures are constituted by a thin layer (~50 nm thickness), external and internal mottled texture with slightly marked striations. Circular to linear marks are common on the external surface of the osteocyte-like microstructures and are interpreted as microbial troughs. Iron (Fe) is the most abundant element found in the osteocyte-like and blood vessel-like microstructures, but not in the bone matrix or collagen fibril-like microstructures. The occurrence of well-preserved soft-tissue elements (at least their physical form) establishes a promising background for future studies on preservation of biomolecules (proteins or DNA) in Messel Pit fossils.

Submitted Publications

DESCRIPTION OF SOME ASPECTS OF NESTING AND NEST EXCAVATION IN WEST (*MECISTOPS CATAPHRACTUS*) AND CENTRAL (*M*. SP. NOV.CF. *CATAPHRACTUS*) AFRICAN SLENDER-SNOUTED CROCODILES. Despite a recent boom in research and conservation activities in western Africa, African Slender-snouted crocodiles (*Mecistops* spp.) remain the least known crocodilians in the world. To date, only a single study has been published covering basic reproductive biology (Waitkuwait 1985). While Waitkuwait (1985) provided a number of important insights into the reproduction of West African Slender-snouted crocodiles (*Mecistops cataphractus*), some questions remain as yet answered for this species. For example, Waitkuwait (1985) was unable to observe whether the female assisted in nest excavation, egg opening, and transporting of hatchlings to the water as observed in other crocodilians. And, as yet, nothing has been published on aspects of reproduction in its Central African congener. We provide observations on nest excavation in captive and wild West (*M*. *cataphractus*) and Central (*M*. sp. nov. cf. *cataphractus*) African Slender-snouted crocodiles [following proposed/impending systematic revisions after Shirley *et al*. (2014)].

West African Slender-snouted crocodiles bred at the St. Augustine Alligator Farm Zoological Park for the first time in 2010. Following observations from the wild that suggest this species can be a shy, secretive nester, the keepers converted the display enclosure's shift area into a nesting area. The shift area has a door that drops down to separate the crocodiles from keepers who need to work on the enclosure, which provided the female an isolated nesting site. Within 2 months of provision of this nesting area, the female constructed her nest inside the enclosure's shift area and laid a total of 23 eggs in June 2010. Eight eggs were left in the nest and the rest were placed into incubators. Two of the 8 eggs hatched and the hatchlings were found in the main pool of the enclosure on 30 August 2010 - an incubation period of 82 days, which was shorter than expected from wild *M*. *cataphractus* observed by Waitkuwait (1985) in the Tai forests of Cote d'Ivoire. At the time, we assumed that the female probably assisted the two surviving hatchlings out of the eggs and to the water because empty eggshells were found floating in the enclosure's main pool about 1.5-1.8 m from the nest. Though this remained unconfirmed through direct observation.

In 2015, the pair successfully nested again, with nest construction and egg deposition in May 2015. Of the 25 eggs laid, 3 were hatched through artificial incubation on 17 August 2015 (82-day incubation), and only one of the 12 eggs left in the nest hatched, on 8 September 2015 (105-day incubation). The latter incubation period is in line with that reported from wild nests.

Instead of placing the 3 hatchlings from the incubator directly back into the main enclosure pool, as we did in 2010, we decided to put them inside the nest with the naturally incubated hatchling upon its emergence. On 8 September 2015 we witnessed the female using her forelimbs and head to unearth the hatchlings, stopping often, presumably to listen for hatchling calls, and we documented hatchling mouth transfer by the female. Video of the mouth transfer can be seen on YouTube (https://www.youtube.com/watch?v=lbME0Etmph8).

Following both the 2010 and 2015 nestings, we left all of the hatchlings in the enclosure to be raised naturally by the parents. Interestingly, the male *M*. *cataphractus* has proven to be a gentle and dutiful caretaker. For example, he was observed retrieving any hatchlings that left the pool, and bringing them back into the water, while the female was retrieving hatchlings from the nest. And, alongside the female, he watches the hatchlings and protects them from any potential predators, including the keepers.

During the 2014 Central African Slender-snouted crocodile breeding season in Loango National Park, Gabon, we found two nests after construction, but presumably before egg deposition in mid-December 2013. To monitor female nest-guarding behavior, we installed a Bushnell Trophy Cam HD camera trap ± 4 m in front of each nest with a clear field of view. Because these camera traps rely on infrared motion detection (ie moving objects with a heat differential to the ambient temperature), we set them to automatically take a picture every 5 minutes. One nest was predated within the first two weeks. most likely by either an ornate monitor (*Varanus ornatus*) or Red-capped mangabeys (*Cercocebus torquatus*) - both were filmed visiting the nest, but neither was filmed actually opening or extracting eggs. The female ceased attending the predated nest.

The second nest successfully hatched and was filmed continuously from mid-December until hatching from the evening of 22 April into the morning of 23 April 2014. This corresponds to an estimated incubation cycle of 113 ± 11 days, depending on the exact date of egg deposition, which was unknown.

During this period, the female was recorded visiting the nest for the first time on 1 January 2014 at 1036 h. She stayed on land adjacent the nest for no more than 20 minutes. After this, she was only filmed attending the nest 12 more times during the entire incubation period, with no regular periodicity. Visit duration was on average only 15 minutes, with the longest visit lasting no more than 45 minutes. In most instances, the female would rest adjacent to the nest or with her snout positioned on the mound, though she was filmed either resting atop or moving over the nest on a few occasions. Unlike *M*. *cataphractus* nests observed by Waitkuwait (1985) in Cote d'Ivoire, this *M*. sp. nov.cf. *cataphractus* nest never developed a furrow across the top from the female resting atop. Unfortunately, the positioning of the camera trap did not allow us to film the water adjacent the nest (<2 m away), and so we cannot comment as to whether the female was more regularly attending the nest but from the water's edge where she would be less vulnerable to predation or other forms of disturbance. It is, as yet, unclear the extent to which this female's nest guarding behavior is representative

of the species, or whether she was simply a young and/or particularly timid individual.

Figure 1. First ever photograph of a female Central African Slender-snouted crocodile (*Mecistops* sp. no. cf. *cataphractus*) guarding a nest (situated behind the female), in the Akaka region, Loango National Park, Gabon. Photograph: Matt Shirley.

Nest excavation began at 1805 h on 22 April 2014, and lasted until 2330 h. During this time the female was filmed using virtually all parts of her body capable of scooping or pulling nest material from atop the mound, including both fore and hind limbs, snout and head, tail, and eventually her entire body. The egg chamber was at the very bottom of the mound, and she eventually reached it at 2330 h, when she was filmed taking the first intact egg in her mouth and down to the water. Over the next 5.5 hours, until approximately 0501 h on 23 April 2014, she was seen continually going back to the nest to take eggs in her mouth and bring them back to the water. Starting midway into the hatching period, hatchling crocodiles can be seen in the leaf litter adjacent the nest until the following photograph shows the trace of the female coming out of the water to take these hatchlings which, presumably, came out of their eggs on their own while the female was attending their clutch mates. From start to finish, the entire process took approximately 11 hours to excavate and hatch approximately 13-16 eggs. The series of photographs on the excavation, assisted hatching, and egg/hatchling mouth transfer can be seen at http://projectmecistops.org/mcongicus/.

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PARAMARIBO'S MOST HISTORIC COMMON SPECTACLED CAIMANS. In northeastern South America, in the Atlantic coastal zone between the mouth of the Amazon and the mouth of the Orinoco, the "common" caiman *Caiman crocodilus* (Linnaeus) is abundant and is called the common kind in the vicinity of the port city of Paramaribo in Suriname (Ouboter and Hoogmoed 1996). The common caiman is the only "spectacled" caiman in Suriname, and the nominate subspecies *Caiman c. crocodilus* (Linnaeus) ranges most abundantly across the northern third of the country, the Atlantic coastal lowlands zone, as compared with the more elevated and mountainous southern two thirds of Suriname, where the smooth-fronted *Paleosuchus* is more frequently encountered (Ouboter and Hoogmoed 1996).

In the interests of clarity and repeatability, the popularly called "common" spectacled caiman needs a single precise locality such as Paramaribo to make sure that the term refers to the *Caiman c. crocodilus* (= *Caiman s. sclerops*) that is the kind of "cayman" or "caiman" (Alligatoridae, Caimaninae) that is common at Paramaribo, meaning Suriname in the Guianas in northern South America, as opposed to the broad-snouted *Caiman latirostris* of southern South America, that also has the "spectacle" ridge, and similarly and additionally the four species-group cayman taxa *yacare*, *fuscus*, *apaporiensis* and *chiapasius* clearly all have the special (gently arched bridge that perpendicularly crosses the skull's long dorsal midline) spectacle ridge also. Further confusingly, *Melanosuchus niger* (present in French Guiana and in the formerly British new nation Guyana) is certainly not a smooth-fronted cayman, because this monotypic special Black caiman genus actually possesses and exhibits something of a bony ridge connecting the front ends of its eye sockets together.

In the first of his two major Crocodylia books, Federico (Fred) Medem (1981) restricted the type locality of the species-group name *Caiman s. sclerops* (Schneider, 1801) to Suriname, and we here further restrict this name's type-locality to Paramaribo in the coastal lowlands zone of the Guianas or Guyanas. The provenance of the figure 10 on plate 104 in Seba (1734) iconotype of *Crocodilus sclerops* Schneider, 1801, is that Mr. A. Seba owned the specimen (dead in alcohol) in Amsterdam, and nothing more. Therefore, it is thus today a matter of historical probabilities that any of the very earliest spectacled caymans from the Guianas must surely have originated in or very near to Paramaribo, if they entered Europe at Amsterdam. Note that Medem (1981) on page 55, concerning the provenance of his figure 41A-41C individual (the one that had been indicated in 1896 by Lönnberg), said that it was "muy probablemente obtenido por Seba de Surinam", thus restricting the type locality. The germane quote from Schneider (1801) in Latin was "ante oculos septum transversum altum format, bene pictum in pictura Sebana 1 tab. 104. fig. 10"; and see our bibliography at Schneider (1801) for the Linnean situation.

The lectotype of *Caiman c. crocodilus* (Linnaeus, 1758) was individually described by Hast (1749), and it is another example of the very earliest of the Amsterdam common (at Paramaribo) spectacled caimans, which in this individual case then traveled (dead in alcohol) further to Sweden. The type locality for *Lacerta crocodilus* Linnaeus, 1758, was restricted from unknown to "Guayana" (in German) by Mertens and Wermuth (1955), and we today further restrict *Caiman c. crocodilus* to Suriname at Paramaribo. Our action makes it clear that the Venezuelan city of Guayana (on the Orinoco River, and a considerable distance inland from the coast) is not the place. Robert Mertens and Heinz Wermuth (1955) said "1758 *Lacerta crocodilus* Linnaeus, Syst. Nat., Ed. 10, 1: 200. - Terra typica restricta: Guayana"; and immediately below it was Schneider's *C. sclerops* with its type locality in 1955 still officially unknown ("unbekannt").

The needed lectotype of *Lacerta crocodilus* was cogently justified and diligently designated as a common spectacled caiman by Hoogmoed and Gruber (1983), and this action was explicitly recommended for CITES in King and Burke (1989). Thus, despite the element of truth in the argument that the species-group name *L. crocodilus* meant the Nile crocodile of Egypt, and its near relatives, the CITES regulated taxon *Caiman c. crocodilus* (Linnaeus, 1758) is a common (at Paramaribo) spectacled caiman, with the Hast (1749) individual owning the name, although in Linnaeus (1735, 1754, 1758, 1766 and 1767) it is hard to know how to interpret the writing.

Helping to clarify the lectotype's identity, Lars Gabriel Andersson's (1900) report said, about the crocodile collections already earlier received from Drottningholm (Museum Drottningholmense) and in 1900 in the Royal Museum in Stockholm, that "there are two jars, labeled *Lacerta crocodilus*, one of which contains two small specimens (230 and 240 mm from the nose to the tip of the tail) of *Caiman sclerops* (Schneider). In the other we find two ova with full-grown foetus, the one of which puts out the head, proving that it probably belongs to *Crocodilus americanus* Laur. It is clear already by Linnaeus's words: 'locus in Asiae, Africae, Americae fervidis' that the name, given by him, is a collective name. According to Lönnberg (1896) the type specimen for the Linnean description in Amoenitates academicae (Amphibia Gyllenborgiana), in which paper Linnaeus first describes *Lacerta crocodilus*, is a *Caiman sclerops*, to which thus, according to my opinion, the Linnean name must be given, and this species then be called *Caiman crocodilus* (L.)." Note that what Andersson (1900) called "Linnaeus Amoen. acad." is our Hast (1749), and that he (Andersson) did not claim in 1900 to have the individual Hast specimen in Stockholm, which is correct because it has always been in the museum of the Royal University in Sweden at Uppsala or Upsala.

The important thing is that Marinus (Rinus) Hoogmoed and Ulrich Gruber (1983) deliberately suggested "selection of the specimen indicated by Lönnberg (1896) as 'type specimen' and by Medem (1981) as 'holotipo' (Univ. Uppsala, s-v length 60 cm, discoloured and desiccated) as the lectotype of *Lacerta crocodilus* L., 1758". Note that there is a discrepancy between the length data above, compared with 60 cm total in Medem (1981). The lectotype's size data in King and Burke (1989) is 60 cm snout to vent (as opposed to total length).

Within the Linnean tradition, only Bartholomaeus Rudolphus Hast's (1749) detailed external physical description (in Latin) is identifiable as the spectacled cayman ("ante vero rugae elevatae oculorum regionem conjungunt"), which we postulate (for historical reasons) is the Paramaribo common kind, as opposed to from somewhere outside of the coastal lowlands of the greater Guianas or Guyanas (Surinam) region. Both the Hast (1749) specimen and the figure 10 on plate 104 in Seba (1734) specimen (the *Caiman s. sclerops* individual) are early Amsterdam caymans and they both undoubtedly have the same locality data as Merian's (1719) illustration of a baby spectacled caiman hatching from its egg in Dutch Suriname, at or very close to Paramaribo. For details about Madame Maria Sybilla Merian's trip to South America and her scientifically important publication of books of highly technically advanced engravings in Europe, based on her own fieldwork paintings from Paramaribo, see Anonymous (1962), which includes the "spectacled cayman" illustration in color on pp. 40-41 (which is the same as our Figure 1, except that it lacks the added letter-a and letter-b subfigure indications, and it is printed much much bigger).

Concerning our Figure 1 illustration, please note that Ouboter and Hoogmoed (1996) explicitly agreed with our identification of the Merian (1719) baby cayman (Figure 1b) as the Paramaribo "common" and "spectacled" kind, and that this individual is from Suriname. The problem with the Figure 1a larger individual is that it is fiction (meaning too stylized) in too many ways.

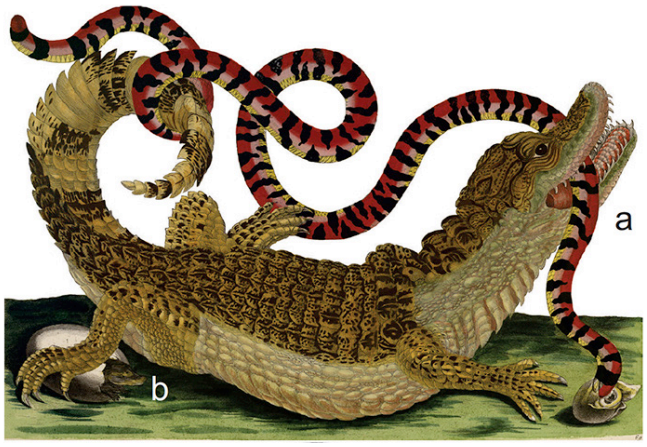

Figure 1. Partly hidden behind and under the large crocodilian's right hind leg is the hatching egg, and the hatchlings's emerging head exhibits the special interorbital "spectacle" ridge that is diagnostic at Paramaribo to *Caiman c. crocodilus* and its junior synonym *Caiman s. sclerops*, both of which now share the exact same restricted (this paper) type-locality. The letters a and b were inserted into Merian's "Surinamse Krokodil" plate 69 by us.

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