

CROCODILE SPECIALIST GROUP NEWSLETTER

VOLUME 38 No. 4 • OCTOBER 2019 - DECEMBER 2019



CROCODILE

SPECIALIST

GROUP

NEWSLETTER

VOLUME 38 Number 4
OCTOBER 2019 - DECEMBER 2019

IUCN - Species Survival Commission

CHAIR:

Professor Grahame Webb
PO Box 530, Karama, NT 0813, Australia

EDITORIAL AND EXECUTIVE OFFICE:

PO Box 530, Karama, NT 0813, Australia

COVER PHOTOGRAPH: Presentation of Conservation Pioneer Award of Excellence for E.A. McIlhenny and the McIlhenny Company and family at the 100-year celebration of Rockefeller Refuge. From left: Tara, Alexander and Michael Rockefeller, Buddy Baker (LDWF), Secretary Jack Montoucet, Christian Brown and wife Kia, Christy Brown and wife Elizabeth, and Buzzy Brown (see pages 4-6).

EDITORIAL POLICY: All news on crocodilian conservation, research, management, captive propagation, trade, laws and regulations is welcome. Photographs and other graphic materials are particularly welcome. Information is usually published, as submitted, over the author's name and mailing address. The editors also extract material from correspondence or other sources and these items are attributed to the source. If inaccuracies do appear, please call them to the attention of the editors so that corrections can be published in later issues. The opinions expressed herein are those of the individuals identified and are not the opinions of CSG, the SSC or the IUCN unless so indicated.

CSG Newsletter

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

The CSG Newsletter provides information on the conservation, status, news and current events concerning crocodilians, and on the activities of the CSG. It is available as a free electronic, downloadable copy from "<http://www.iucncsg.org/pages/Publications.html>".

All CSG communications should be addressed to:
CSG Executive Office, P.O. Box 530, Karama, NT 0813, Australia.
Fax: +61.8.89470678. E-mail: csg@wmi.com.au.

PATRONS

We thank all patrons who have donated to the CSG and its conservation program over many years, and especially to donors in 2018-2019 (listed below).

Big Bull Crocs! (\$15,000 or more annually or in aggregate donations)

Japan Leather & Leather Goods Industries Association,
CITES Promotion Committee & Japan Reptile Leather
Industries Association, Tokyo, Japan.

Heng Long Leather Co. Pte. Ltd., Singapore.

International Crocodile Farmers Association, Paris, France.

Louisiana Alligators Farmers and Ranchers Association,
Abbeville, Louisiana, USA.

Reptile Tannery of Louisiana, Lafayette, Louisiana, USA/
Hermes Cuirs Precieux, Paris, France.

Singapore Reptile Skin Trade Association, Singapore.

United Leather Products Co., Ltd. and Nakorn Sawan
Crocodile Farm, Thailand.

Wall's Gator Farms LLC, Louisiana, USA.

Wall's Gator Farm II LLC, Louisiana, USA.

Friends (\$3000 - \$15,000)

Christy Plott, American Leather and Tanning Company LLC,
Georgia, USA.

Coral Agri-Venture Farm, Philippines.

Enrico Chiesa, Italhide, Italy.

Donald Farms, Louisiana, USA.

Jake Puglia, Alligator Adventures, USA.

Mainland Holdings, Lae, Papua New Guinea.

Phillip Cunliffe-Steel, New Zealand.

Sam Seashole, Crocodile Conservation Institute, USA.

St. Augustine Alligator Farm, Florida, USA.

Wayne Sagrera, Vermilion Gator Farm, Louisiana, USA.

Virginia Aquarium and Marine Science Center Foundation,
Virginia Beach, Virginia, USA.

Supporters (\$1000 - \$3000)

Simone Comparini, Pantera S.R.L., S. Croce s/Arno, Italy.

Crocodile Cooperative of Thailand and Crocodile
Management Association of Thailand, Thailand.

Ebey family, New Mexico, USA.

Paolo Martelli, Hong Kong.

J.K. Mercado & Sons Agricultural Enterprises, Philippines.

Phoenix Herpetological Society, Arizona, USA.
R.J. Rao, Gwalior, India.
George Saputra, CV Alona Jaya, Jakarta, Indonesia.
Zambia Crocodile Farmers Association, Lusaka, Zambia.

Contributors (\$250 - \$1000)

Allan Woodward, Florida, USA.
Cathy Shilton, Northern Territory, Australia.
Croc Encounters of Tampa, Florida, USA.
Lou Densmore, Texas, USA.
Dresden Zoo, Dresden, Germany.
Richard Fergusson, Mozambique.
James Hennessy, The National Reptile Zoo, Ireland.
Libor Kopečný, Czech Republic.
Jeff Lang, Minnesota, USA.
Matthew Shirley, Florida, USA.
Zoo Atlanta, Georgia, USA.
Zoological Society of Hertfordshire, UK.

Editorial

At the last CSG Working Meeting in Argentina, it was apparent that major changes were taking place in the global crocodile industry, that were adversely affecting the conservation benefits being derived from the commercial use of some crocodilian species. The concerns were articulated within a facilitated workshop chaired by Perran Ross and Alan Woodward at the Working Meeting, and efforts were made after that, to better understand what was happening and why, and how events in Southeast Asia and China were involved. But events have moved rapidly since that time.

Overproduction was being encouraged by the market, but at a time when Animal Rights activists were ramping up their strategic attacks on the major brands within the public arena, and infiltrating boardrooms with deals within deals. The basic animal rights position was that it was irresponsible and unethical to use exotic leathers. Indeed, to use any leathers, when new alternative materials made from vegetable-based products or even non-renewable resources were available. The brands and farming industries have responded to this commercial situation in various ways, but the conservation and humanitarian consequences of their actions are mixed. The UN Sustainable Development Goals are steadily being adopted by corporations, but more as selected individual goals rather than as an holistic humanitarian framework with poverty alleviation as the central goal. This whole situation became further complicated by events within California, one of the world's largest economies, which intends banning trade in crocodiles, alligators, caimans, pythons, lizards and a raft of other animals, regardless of the adverse conservation consequences of doing so.

Incentive-driven conservation is not a panacea for world crocodilian conservation, but it has certainly helped marshal Government and private sector interest and resources in ways that favour conservation. While this is well understood within the CSG, it is clearly not well understood by the urban public, and so the CSG story needs to be better told.

In California, we have Louisiana to thank for fighting the proposed ban. Penal Code 6530(b) was supposed to come into effect on 1 January 2020, but is now being challenged legally. Just before Christmas, the Louisiana and the State of California agreed that a pending lawsuit in the federal court in Sacramento that California will not start enforcing any part 6530(b) until late April 2020 at the earliest. There remain legal questions as to whether California has the right to reintroduce a trade ban from 1970, given that CITES came into effect (1975) subsequently, and international obligations under CITES obligations for trade in CITES-listed species fall primarily under federal not state legislation. Hence 2020 will hopefully see some resolution of what appears to be a complicated political action with serious adverse conservation consequences.

Phoebe Griffith, a student from Bristol University, UK, currently undertaking a project "Building an Evidence Base for Gharial (*Gavialis gangeticus*) Conservation in Nepal" with SRAS support has been successfully putting tracking transmitters on Gharial, and so many questions about gharials in Nepal may soon be answered. Since 2009, SRAS has so far supported 175 projects by students from 41 countries.

In mid-December, Rainier Manalo, Regional Vice Chair for East and Southeast Asia, reported a verification survey on a new population of Philippine crocodiles (*Crocodylus mindorensis*) in Malabang, Lanao del Sur, Island of Mindanao, Philippines. This research has been supported by Crocodylus Porosus Philippines Incorporated, the Philippine crocodile industry association (see pages 6-9).

There are a series of upcoming meetings that may be of interest to CSG members. The 9th World Congress of Herpetology will be held in Dunedin, New Zealand, on 5-10 January 2020 (www.wchnz.com).

Details for the 26th CSG Working Meeting, in Chetmual, Quintana Roo, Mexico, to be held on 4-7 May 2020, can be accessed at www.biodiversidad.gob.mx/planeta/csg2020/programa.html. This promises to be an excellent, well-attended meeting.

France will host the IUCN World Conservation Congress on 11-19 June 2020 at Parc Chanot in Marseille, France. The Congress brings together several thousand leaders and decision-makers from Government, civil society, indigenous peoples, business, and academia, with the goal of conserving the environment and harnessing the solutions nature offers to global challenges.

The 23rd International Congress of Zoology will be held in Capetown, South Africa, on 19-24 July 2020. The theme of the meeting is "Zoology in the Anthropocene - A Holistic Integrated Approach to Conservation". Information brochure can be downloaded at <https://icz2020.co.za>.

Professor Grahame Webb, CSG Chair.

CSG Student Research Assistance Scheme

The Student Research Assistance Scheme (SRAS) provided funding to 10 students in the October-December 2019 quarter. Four further applications are currently under review.

1. Brinky Desai (India): Understanding reproductive profiles of Mugger crocodiles using non-invasive fecal hormone metabolite measurements within the human-dominated habitat of central Gujarat.
2. Jazmin Bauso (Argentina): *Caiman latirostris* as an indicator of heavy metals present in environments with different levels of anthropization.
3. Julio Guterrez-Ramirez (Mexico): Evaluation of the translocation of *Crocodylus moreletii* at Yum Balam, Quintana Roo, Mexico.
4. Lucia Odetti (Argentina): Patterns of gene expression as bioindicators of exposure to pesticides in *Caiman latirostris*.
5. Juan Moncada-Jimenez (Colombia): Genetic characterization of populations of *Crocodylus acutus* in protected areas of Caribbean Colombia.
6. Line Skipper Jensen (Denmark): Nile crocodiles and effectiveness of protected area in East Africa.
7. Nicolas Ramirez-Cardenas (Colombia): Population ecology of the American crocodile (*Crocodylus acutus*) and the Brown caiman (*Caiman crocodilus fuscus*) in Salamanca Island Road Park, Caribbean Colombia.
8. Andrea Escamilla López (Mexico): Determination of polycyclic aromatic hydrocarbons (PAHs) and organochlorine pesticides (OCPs) in Morelet's crocodile (*Crocodylus moreletii*) and its prey in the Emiliano Zapata region, Tabasco, Mexico.
9. Kassahun Delene (Ethiopia): Isolation and identification of *Salmonella* species from juvenile Nile crocodiles (*Crocodylus niloticus*) at Arba-Minch Crocodile Ranch, Arba-Minch, Ethiopia.
10. Clare Wilkie (UK): Hybridization between Morelet's Crocodiles (*Crocodylus moreletii*) and American Crocodiles (*Crocodylus acutus*) in Belize.

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

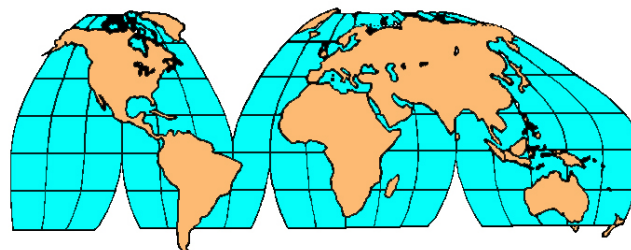
26th CSG Working Meeting (Chetumal, Quintana Roo, Mexico, 4-7 May 2020)

The 26th CSG Working Meeting will be held in Chetumal, Quintana Roo, Mexico, on 4-7 May 2020, and will be preceded by a Veterinary Workshop (2 May) and CSG Steering Committee meeting (3 May).

The meeting website (<https://www.biodiversidad.gob.mx/planeta/csg2020/comite.html>) has now been launched, and provides details on registration, the venue, accommodation, guidelines for authors, etc.

We encourage CSG members and others interested in crocodilian research, management and conservation to attend this working meeting, and look forward to seeing you in Chetumal, Mexico, in 2020.

Regional Reports



North America

USA

100 YEARS OF WILDLIFE CONSERVATION CELEBRATED AT ROCKEFELLER WILDLIFE REFUGE. Rockefeller Wildlife Refuge, located in Cameron and Vermilion Parishes in southwest Louisiana, has long been managed as a haven for wildlife, avian and fish species. The refuge, managed by the Louisiana Department of Wildlife and Fisheries (LDWF), encompasses some 70,000 acres of coastal land fronting the Gulf of Mexico. Numerous species of animals inhabit the refuge, in particular alligators and waterfowl, as well as furbearers and a wealth of fisheries resources. The research done at Rockefeller in the 1950s, 1960s and 1970s helped in understanding the American alligator life cycle and assisted in the removal of the species from the Endangered Species List. Numerous CSG members have visited Rockefeller over the years, to learn about the alligator research conducted there or to undertake collaborative studies.

Rockefeller is a coastal wetland bordering the Gulf of Mexico for 42 km and extending inland to the Grand Chenier ridge, a stranded beach ridge 9.6 km from the Gulf. Its flat, mostly treeless and perfect for resident and migratory waterfowl and geese thanks to the organic soils that produce copious amounts of waterfowl food.

But the name wildlife refuge barely scratches the surface when considering this unique Louisiana treasure. The Rockefeller of New York and Edward Avery McIlhenny, whose family created and produces the famous Tabasco Brand Pepper Sauce, were the driving forces behind the establishment of Rockefeller Refuge. Previously, McIlhenny helped develop the State Wildlife Refuge in Vermilion Parish and Marsh Island Wildlife Refuge in neighbouring Iberia Parish.

After helping to acquire those two refuges in the early 1910s, McIlhenny and Charles Willis Ward, another conservationist whom McIlhenny met in a Louisiana bait shop, began work to purchase 86,000 acres in western Vermilion and eastern Cameron Parishes that would become Rockefeller. They bought the land for \$212,500 (which translates to about \$5.3 million today) through the Rockefeller Foundation in 1914. On 18 December 1919, the property was donated to the state. Thus, 100 years later this generous donation was recognized at a celebration of Rockefeller held on 23 October 2019.

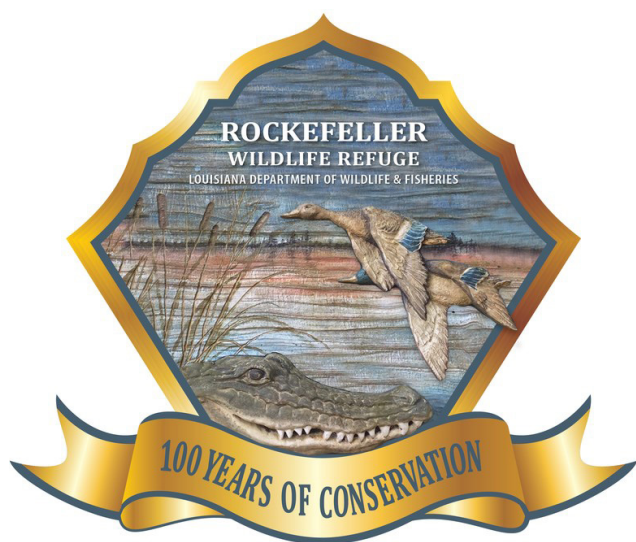


Figure 1. Rockefeller Refuge 100-year celebration logo.

When McIlhenny donated Rockefeller to the state he had put in writing in the deed of donation several terms, including that the property had to be maintained as a wildlife refuge, boundaries had to be posted, enforcement agents had to protect the area, no hunting or fishing would be allowed, and the refuge staff had to study and manage the property for wildlife. Recreational fishing is now permitted on the site, however, hunting remains prohibited.

Though the top priority for McIlhenny when he created the refuge was waterfowl, much more has been done on Rockefeller. The refuge provides habitat for more than ducks and geese, and some of the common resident animals on the property include alligators, white-tailed deer, and furbearing animals including nutria, muskrat, mink, and otter. There is an abundance of freshwater and estuarine fish species such as largemouth bass, redfish, speckled trout and black drum.

Rockefeller Refuge is well known for an extensive history of alligator research, and the conservation significance of the property was recognized by CSG Chair Prof. Grahame Webb, who spearheaded an effort to acknowledge the contributions of Edward McIlhenny and his family earlier this year. McIlhenny's work was applauded in a formal letter from Professor Webb (CSG Chair), Professor Jon Paul Rodriguez (Chair, Species Survival Commission, and Ms. Inger Andersen (then Director General of the International Union for Conservation of Nature). A formal presentation of this Conservation Pioneer Award of Excellence for E.A. McIlhenny and the McIlhenny Company and Family (Fig.

2) was made at the 100-year celebration to members of the McIlhenny family in attendance (Fig. 3). We were pleased to host several members of the Rockefeller family as well (see front cover).



Figure 2. Conservation Pioneer Award of Excellence for E.A. McIlhenny and the McIlhenny Company and Family presented to members of the McIlhenny family in attendance at the 100-year celebration at Rockefeller Refuge.



Figure 3. Secretary Jack Montoucet (left) presenting the IUCN Conservation Pioneer Award of Excellence to McIlhenny family member Christy Brown.

LDWF personnel told the story of Rockefeller during the celebration event that included tours of the refuge for those attending. After a welcome and introduction of guests from the Rockefeller and McIlhenny families, a historical perspective of work done at the refuge was given, and past and present staff members were recognized; these presentations were made by LDWF Secretary Jack Montoucet, Biologist Administrator Buddy Baker, and Rockefeller Program Manager Phillip "Scooter" Trosclair. The contributions of the refuge to wildlife conservation were covered in talks on habitat stewardship (by Program Manager Phillip "Scooter" Trosclair), research (by Biologist Manager Ruth Elsey), endangered species recovery (by Biologist Supervisor Joe Marty, Fig. 2), education and public outreach (by Public Information Officer Gabe Giffin), and the importance of the refuge to the local community by State Representative (District 47) Mr. Ryan Bourriaque,

who was a student employee at Rockefeller on the “alligator crew” when a college student. Guests enjoyed sharing lunch together; the “southern hospitality” menu included brisket, shrimp fettuccini, rice dressing, corn, green beans, rolls, bread pudding, and pecan pie. Lunch was followed by field trips including aerial views of the property by helicopter and seaplane, airboat tours of impoundments, crew boat trips to see shoreline stabilization projects to encourage wetlands restoration, and tours of the new laboratory facility. Local news media covered the event, and some 200 participants were in attendance. We thank the many generous donors who sponsored the celebration.



Figure 4. Guests listening to a slide presentation by Dr. Joe Marty, which included information on alligator recovery work done at Rockefeller Refuge.

Ruth Elsey, *Louisiana Department of Wildlife and Fisheries and CSG Regional Co-Chair for North America* (relsey@wlf.la.gov).

WINTER CROCFEST 2019. Winter CrocFest 2019 took place on 7 December 2019 at St. Augustine Alligator Farm Zoological Park in St. Augustine, Florida, USA. The event was attended by 295 supporters and raised over \$US46,000 for research and conservation efforts benefiting American crocodiles (*Crocodylus acutus*) in five countries (Belize, Colombia, Costa Rica, Guatemala, USA). Due to increased pressure from expanding human populations in these Range States, the American crocodile faces an array of threats to its continued existence. Through their proposed works, the researchers listed below seek to establish baseline data and then formulate strategies to reduce human-crocodile conflict and help ensure the conservation of healthy ecosystems and American crocodile populations in their respective regions:

1. Marisa Tellez, Crocodile Research Coalition: Crocodile Conservation & Community Stewardship in Belize.
2. Sergio Balaguera-Reina: Spatial Ecology of the American Crocodile in a Highly-Visited Protected Area in the Colombia Caribbean.
3. Mahmood Sasa Marin, Christopher Murray and Mark Merchant: Pollution by Dispersal: Transport Mechanisms for Endocrine Disrupting Contaminants in Vanishing Wetlands (Costa Rica).

4. Valerie Corado Garcia and Jose Octavio Cajas: Update on the Status of the Populations of *Crocodylus acutus* in Two Guatemalan Protected Areas of the Pacific and Atlantic Slopes.

5. The Croc Docs, University of Florida-FLREC: Using a Threatened Species to Monitor an Endangered Ecosystem: The American Crocodile (*Crocodylus acutus*) in the Florida Everglades.

Proceeds from this event will be combined with funds raised at Summer CrocFest 2019, and then distributed to the project beneficiaries.

Highlights at Winter CrocFest included the Croc Docs, represented by some 30 attendees at CrocFest (including Frank Mazzotti and Venetia Briggs-Gonzalez), presenting the 2019 Rafael Crespo Conservation Fund Award to Dr. Sergio Balaguera-Reina (Fig. 1) at the live auction (Fig. 4). In addition, David Drysdale and John Brueggen of St. Augustine Alligator Farm were presented the 2019 Ralf Sommerlad Crocodile Conservation Award (Fig. 2), recognizing them for substantial contributions in support of crocodilian captive husbandry and conservation.



Figure 1. Sergio Balaguera-Reina (centre), accepts the 2019 Crespo Award, presented by the Croc Docs and Rafael Crespo's parents.

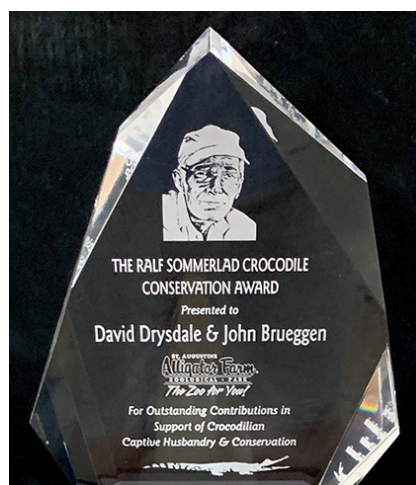


Figure 2. The Ralf Sommerlad Conservation Award was presented to St. Augustine Farm Zoological Park owner, David Drysdale, and director, John Brueggen.

Special thanks to our Winter CrocFest 2019 host - St. Augustine Alligator Farm Zoological Park - which opened its front admissions gate for CrocFest ticket sales. Guests enjoyed touring the grounds of The Alligator Farm and were treated to encounters with some of the park's most endearing inhabitants. As a special treat, there was a public feeding of Maximo, an impressive, nearly 5 m male Saltwater crocodile (Fig. 3). Attending CrocFest were "Alligator Frank Robb" and the alligator named "Chance the Snapper," both of whom have become celebrities over the last six months! Robb signed copies of a new coloring book that recounts the story of the alligator's unfortunate release into a Chicago lake, his capture by Robb and happy relocation to St. Augustine Alligator Farm.

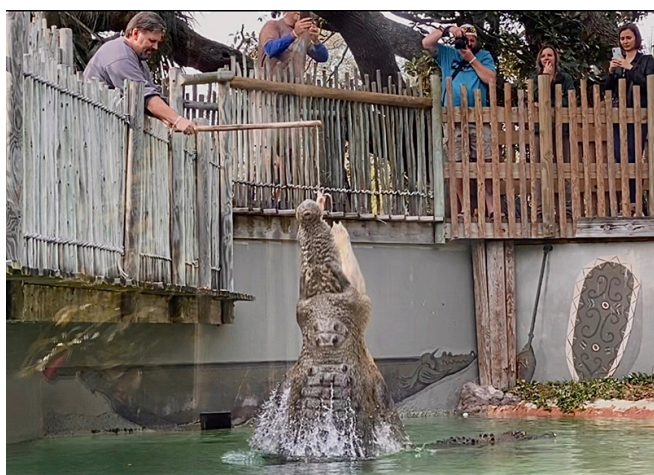


Figure 3. "Maximo" delights hundreds of CrocFest attendees as he explodes out of the water during a feeding demonstration.



Figure 4. CrocFest crowd assembles in anticipation of the live auction.

Thanks to the generosity and commitment of the private sector, zoos, academia, and corporate sponsors, over the past nine years, CrocFest has raised over \$US463,000 for crocodilians in peril. ALL donations go directly to the crocodile projects, with fundraiser expenses covered by sponsors and event organizers.

The CrocFest Team: Colette Adams, Curt Harbsmeier and Flavio Morrissiey.

East and Southeast Asia

Philippines

NEW POPULATION RECORD OF PHILIPPINE CROCODILE (*CROCODYLUS MINDORENSIS*, SCHMIDT, 1935) IN SOUTHERN PHILIPPINES. On 27 November 2018, the Crocodylus Porosus Philippines, Inc. (CPPI) Research and Conservation Team traveled to the Municipality of Malabang, Province of Lanao del Sur, Mindanao (Fig. 1) to investigate the reported presence of crocodiles in the area. They immediately encountered two sub-adults and one juvenile crocodile in private collections. Morphological investigation showed that the three individuals were Philippine crocodiles (*Crocodylus mindorensis*). An interview with the incidental captor of one of the sub-adults revealed that it was accidentally caught in the Matling River during a fishing trip. Due to uncertainty on the presence of wild population and its close proximal boundaries, this finding was deemed inconclusive enough to establish a new population record at the time of visit.

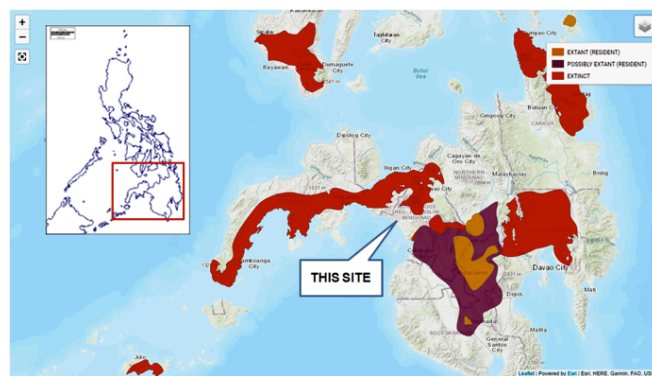


Figure 1. Location of new *Crocodylus mindorensis* population record in the Municipality of Malabang, Lanao del Sur. Based on map in Ross *et al.* (2016).

A year later, on 28 November 2019, Philippine National Police Officer Patrolman Saino Benito Pagayawan (former Forest Ranger of the DENR-Autonomous Region for Muslim Mindanao and a resident of the Municipality of Malabang, Lanao del Sur) posted a photograph of a juvenile Philippine crocodile on CPPI's official Facebook page "Philippine Croc". With this information in hand, CPPI mobilized its team to renew investigative efforts on-site to examine the reported juvenile crocodile further.

On 10 December 2019, the team was able to examine the reported by-catch juvenile Philippine crocodile (Fig. 2) which was kept in a small, improvised earthen enclosure. Morphological investigation confirmed that the juvenile crocodile was a *C. mindorensis* (103 cm TL). Mr. Gani Macaraya (38 y), Mr. Mohaymi Macaraya (32 y) and Mr. Talha Doronia (31 y) collectively revealed that the individual was accidentally captured during their fishing trip in Maladi River, Barangay Montay, Municipality of Malabang, Lanao del Sur, around 1300 h on 17 November 2019. Mr. Macaraya recalled that he also tied a rope to the neck area of an adult



Figure 2. By-catch juvenile *Crocodylus mindorensis* from the Maladi River, Malabang, Lanao del Norte, Philippines, retrieved by PNP Officer Patrolman Saino Benito Pagayawan, December 2019.

crocodile resting underwater during one of his spear fishing trips last October 2019, but that crocodile escaped. He also reported having seen an adult crocodile basking in the area prior to this occasion.

With the assistance of the Philippine Marine Battalion Landing Team and community guides, CPPI conducted an on-foot night spotlighting survey in the Maladi River ($7^{\circ}37'47.94''$ N; $124^{\circ}3'22.90''$ E, WGS84), which yielded no crocodile sightings. However, a concerned resident reported the accidental capture on 8 December 2019 of three young crocodiles of apparently varying ages. Upon further field investigation, the nesting site was found to be in a densely vegetated, waterlogged area with irrigation drainages serving as narrow waterways (ca. 300 m) from the Miundas River ($7^{\circ}38'8.67''$ N; $124^{\circ}2'45.12''$ E WGS84) in the same municipality. Close morphological examination of the one of the three young individuals confirmed it to be about a 2-week-old hatchling *C. mindorensis* (33 cm TL). Tissue samples from tail scutes clipping were obtained and will be used for DNA sequencing to determine its relationship from previously sampled individuals in the Provinces of Lanao.

The hatchling was released by the community back to the wild after examination. On 11 December 2019, a daytime survey along the capture site ($7^{\circ}37'28.95''$ N; $124^{\circ}2'50.46''$ E WGS84) of the juvenile in the Maladi River revealed several fresh juvenile crocodile tracks in sand along the riverbanks.

The elusive nature of the Philippine crocodile causes it to be considered as the rarest species of crocodile in the world. Historically, this species was distributed throughout the country with records in the Laguna de Bay, Camarines Province, Oriental Mindoro, Busuanga Island in Palawan Province, Samar, Negros Oriental, Zamboanga del Sur, Ligawasan Marsh, North Cotabato, Davao del Norte, and Surigao del Norte (Ross *et al.* 2016). The IUCN Red List estimated the extant population at 92-137 individuals, that are patchily distributed in the Province of Abra (Manalo 2008), the foothills of the Northern Sierra Madre mountain range in Isabela (van Weerd *et al.* 2006) and Dalupiri Island (Oliveros *et al.* 2005) in northern Luzon. Extant populations were also present in Ligawasan Marsh (Pomares *et al.* 2008), the central spine of Bukidnon (Pontillas 2000) and the highlands of Lake Sebu in South Cotabato (Manalo *et al.* 2018) in Mindanao.

In 2013, 36 captive-bred juveniles were introduced in Paghungawan Marsh, Siargao Island Protected Landscapes and Seascapes off the north coast of Mindanao (Mercado *et al.* 2013). Then in 2017, there was a supplementary release of 8 yearlings and 21 juveniles in the marsh as requested by the local government unit (Manolis 2017). There was no known previous record of *C. mindorensis* in Moro Gulf, Lanao del Sur, western Mindanao, Philippines (see Fig. 1).

The records of *C. mindorensis* hatchlings and juveniles in this field survey undoubtedly confirm the presence of a healthy, apparently viable population thriving in the major river systems (Miundas, Maladi and Matling) in Lanao del Sur. This population, hidden to science for almost four decades, was in fact well known to the local community. These findings signify that Mindanao remains the stronghold population of this species. We perceive that its existence will continue into the next decades through protection afforded by the cultural practices of the indigenous Muslim communities nearby.

Conservation of *C. mindorensis* heavily relies on the commitment to explore new habitats that may potentially harbor extant populations. It is an additional benefit to find them in an environment where the local culture naturally provides for its protection. CPPI is very much willing to facilitate future research and conservation partnerships among government institutions, non-government organizations, international institutions, funding agencies, and community leaders whenever and wherever warranted.

Acknowledgements

We would like to express our thanks to Patrolman Saino Benito Pagayawan for providing information on this new population; likewise to Brgy. Montay Chairman Anwar Sabat S. Pagayawan, Mr. Hasim Macaraya, for their hospitality; to Mr. Baulo Baharodin of the Ministry of Environment Natural Resources and Energy - Bangsamoro Autonomous Region for Muslim Mindanao, for technical support in permitting



Figure 3. *Crocodylus mindorensis* hatchling recovered from tributary of the Miundas River, Malabang, Lanao del Sur, Philippines, December 2019.

process; to the logistic support of the 5th Philippine Marine Battalion Landing Team; and, finally, to Crocodile Conservation Institute for its generous support.

Literature Cited

- Manalo, R.I. (2008). Occurrence of *Crocodylus mindorensis* in the Cordillera Central, Abra Province, Luzon Island. National Museum Papers 13(1-4): 109-115.
- Manalo, R.I., Fontanilla, I.A.C., Pedales, R.D., Pomares, C.C. and Corvera, M.D. (2018). Evidence on the presence of the Critically Endangered Philippine Crocodile, *Crocodylus mindorensis* (Schmidt 1935) in the highlands of Daguma Mountain Range, Lake Sebu, the Philippines. Multidisciplinary Advances in Veterinary Science 2(1): 276-282.
- Manolis, C. (2017). Second release of Philippine crocodiles at Paghungawan Marsh, Pilar, Siargao Island. Crocodile Specialist Group Newsletter 36(2): 14.
- Mercado, V.P., Alcala, A.C., Belo, W.T., Manalo, R.I., Diesmos, A.D. and de Leon, J. (2013). Soft release introduction of the Philippine Crocodile (*Crocodylus mindorensis*, Schmidt 1935) in Paghungawan Marsh, Siargao Island Protected Landscape and Seascape, Southern Philippines. Crocodile Specialist Group Newsletter 32(1): 13-15.
- Oliveros, C., Manalo, R., Coñate Sr., E., Tarun, B., Telan, S. and Van Weerd, M. (2005). Philippine crocodile recorded on Dalupiri Island. Crocodile Specialist Group Newsletter 24(3): 14-15.
- Pomares, C.C., Pomares, M.P. and Escalera, C.M.R. (2008). The existence of wild crocodile populations in Ligawasan Marsh and its tributaries. National Museum Papers 14: 116-122.
- Pontillas, F. (2000). New breeding sites for the Philippine crocodile. Crocodile Specialist Group Newsletter 19: 7-12.
- Ross, P., Van Weerd, M. and Manalo, R. (2016). *Crocodylus mindorensis*. The IUCN Red List of Threatened Species. Version 2019-3.
- Van Weerd, M., Van der Ploeg, J., Rodriguez, D., Guerrero, J., Tarun, B., Telan, S. and de Jonge, J. (2006). Philippine crocodile conservation in Northeast Luzon: an update of population status and new insights into *Crocodylus mindorensis* ecology. Pp. 306-321 in Crocodiles. Proceedings of the 18th Working Meeting of the IUCN-SSC Crocodile Specialist Group. IUCN: Gland.
- Rainier I. Manalo, Jake Wilson B. Binaday, Philip C. Baltazar, Meljory D. Corvera and Chris John C. Ladiana; *Crocodylus Porosus Philippines, Inc., Pag-asa Farms, Kapalong, Davao del Norte, Philippines* (www.philippinecrocodile.com.ph, philippinecroc@gmail.com).

South Asia and Iran

India

MARSH CROCODILES OF KARKATGARH-KAIMUR (BIHAR, INDIA). Kaimur Wildlife Sanctuary (KWLS), ~1500 km² in area, largely consists of Vindhyan sandstones in a scarp and plateau formation with dry deciduous and open scrub vegetation. The Karamnasa is the major perennial river in study area, draining a large part of the plateau in a series of waterfalls and cascades to meet the Ganga in the north. Karkatgarh lies in the northwestern part of KWLS, and the Karamnasa River forms the interstate boundary between the states of Bihar and Uttar Pradesh at this location.

In February-March 2019, 36 km of river/stream habitat (including Karamnasa, Lorsi and Phulbaria-Thupata-Okhargarha-Gurwat) were surveyed over a 15-day period. The habitat here is characterised by riparian vegetation and a rocky bed. Late-winter, low-flow conditions were advantageous because crocodiles were confined to fewer locations and expected to bask for longer durations. Counts were based on daylight foot and stationary observations.

A total of 80 crocodiles were recorded from 45 locations; 36 adults (≥ 200 cm TL), 9 sub-adults (150-199 cm TL), 24 juveniles (60-149 cm TL), 5 yearlings (< 60 cm TL) and 6 of indeterminate size. Data on crocodile signs, including spoor (tail, foot, belly scales and slide impressions), scat (faecal pellets) and burrows were recorded to help determine presence, but not used in the reported figure to avoid double counts. No attempt was made to estimate the probability of detection or measures of survey bias or error.

Major anthropogenic influences observed during the survey include hydrological modifications (dams and unseasonal flows), gill-net fishing, riverbed farming, and tourism. A conservation and monitoring plan has been prepared for the Department of Environment, Forest and Climate Change, Government of Bihar, focusing on: (a) staff training and capacity building; (b) protection and patrolling; (c) crocodile monitoring; (d) monitoring river flow; and, (e) communication and outreach.

The full report (Nair and Varma 2019) can be shared conditional on approval from the concerned department.

Literature Cited

- Nair, T. and Varma, G. (2019). Marsh Crocodiles of Karkatgarh: Survey Report and Conservation Plan for Marsh Crocodiles (*Crocodylus palustris*) in the Karkatgarh Area of Kaimur Wildlife Sanctuary, Bihar. 41 pp.
- Tarun Nair, *Ashoka Trust for Research in Ecology and the Environment, Bengaluru, India* (tarunnair1982@gmail.com, tarun.nair@atree.org).

RELICTS IN THE RIVER: SHORT SURVEY FOR GHARIALS (*GAVIALIS GANGETICUS*) IN THE KOSI RIVER, INDIA. We report the findings of a short survey for Gharials (*Gavialis gangeticus*) in the Kosi River (Bihar, India), conducted during a population monitoring exercise for South Asian River Dolphins (*Platanista gangetica*). Our observations are perhaps the first documented record of wild Gharials in the Kosi River in about 50 years. We also share details of a Gharial rescued near Sitapur in 2018.

The Kosi River (Koshi in Nepal) is a major Himalayan river in the Gangetic Basin. It enters India from Nepal, near Bhimnagar, and after a (present) course of approximately 230 km through the East Indian state of Bihar, joins the Ganga River near the town of Kursela. The Kosi is well-known for the dramatic shifts in course across its megafan, the east-west oscillating movements of the channel caused by random nodal avulsion processes (Sinha 2008; Chakraborty *et al.* 2010), and high sediment flux (Sinha *et al.* 2019). Major alterations in the river channel and floodplain include the Kosi Barrage near Bhimnagar, and embankments along both banks of the river which has resulted in increased in-channel sedimentation.

Presently, the main flow of the Kosi in India is confined (by embankment) at the western flank of the fan where it is braided along its upper and middle course, and meandering in the lower. In addition, several single-threaded meanders (remnants of past courses) are spread across the fan surface and these are fed either by groundwater or seepage from the Kosi River (Gaurav *et al.* 2015).

Methods

We surveyed ~175 km of the Kosi River covering the distance between the India-Nepal border (26.4816° N, 86.8978° E, approximately 5 km downstream of the Kosi Barrage) and Dumri Bridge (25.5427° N, 86.7237° E). The survey was conducted in the up-river and down-river directions, with a total survey effort of about 350 km over 12 days, between 22 January and 2 February 2019 (Fig. 1).

The survey team consisted of two dolphin observers and one data recorder seated at the bow of the boat; one team leader-cum-coordinator and one Gharial observer positioned midship; and, two boat-men at the rear.

Survey equipment included roof-prism binoculars (10x42) and digital camera (50x optical zoom) to make and record observations; hand-held GPS device to record locations; sonar chart plotter (set to a 6 second interval) to record depth; and, cup-type (\approx Price AA) current-meter to measure flow velocity.

The survey was designed with the primary objective of counting river dolphins and was less suited for detecting Gharials. Specifically, boat speed (\sim 10 km/h moving downriver and \sim 5 km/h upriver), vessel type (diesel outboard motor-powered country boat with poor sound and vibration damping), and bathymetrical constraints in some reaches

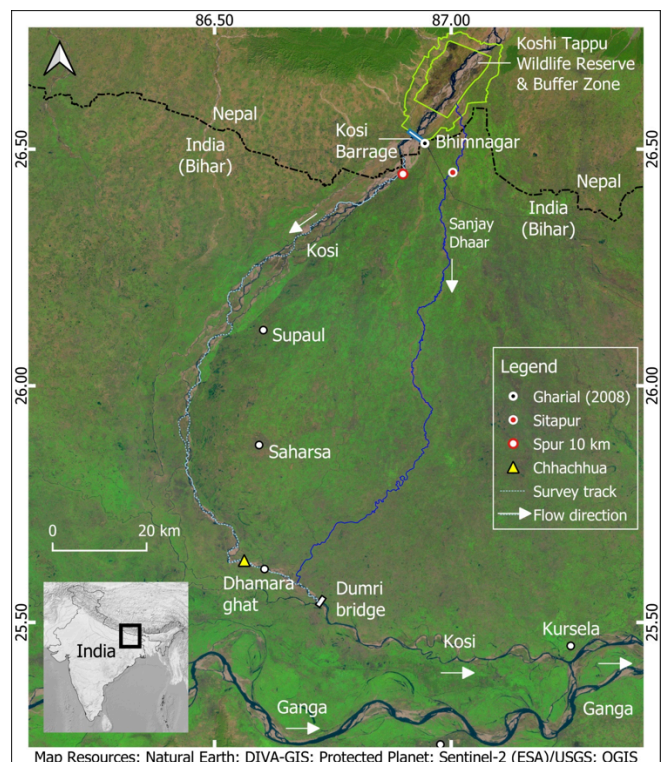


Figure 1. Map of the Kosi River and key locations.

(navigation along/near thalweg, and not channel midline, due to insufficient depth) are likely to have influenced observations and Gharial detectability.

Observations

Two Gharials, one adult (300-330 cm TL) and one sub-adult (\sim 200 cm TL), were observed basking on a sandbar near Chhachhua (approximately 5 km upriver from Dhamara Ghat) on 28 and 29 January 2019 (Figs. 2 and 3). From field observations and examination of photographs, we did not see any signs (clipped or tag-punched tail scutes) to suggest these were reintroduced Gharials. A floodplain farmer nearby reported seeing up to three Gharials basking together at this general location over the last two years. Similarly, fishermen at Dhamara Ghat also indicated that a few animals may be found near Chhachhua.



Figure 2. Adult Gharial on a Kosi sandbar near Chhachhua, Bihar, on 29 January 2019. Photograph: Tarun Nair.



Figure 3. Sub-adult Gharial on a Kosi sandbar near Chhachhua, Bihar, on 29 January 2019. Photograph: Tarun Nair.

Maximum recorded depth was 9.8 m in the surveyed section, while maximum depth in the vicinity of the Gharials was 5.5 m (Fig. 4). Mean river discharge was 247.8 m³/sec during the survey period.

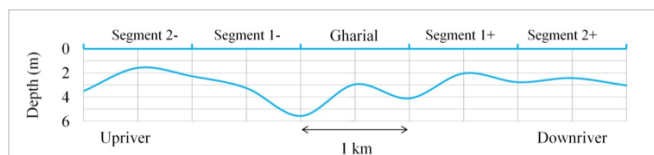


Figure 4. Longitudinal profile of thalweg depths at 0.5 km intervals of a 5-km segment centred at Gharial observation site.

While no immediate direct threats to Gharials were observed in this particular river reach, gillnet fishing and bird hunting using gillnets (set up in the manner of mist-nets) and pesticide (Carbofuran) coated baits was observed upriver and downriver of this reach. Five poisoned ruddy shelducks (*Tadorna ferruginea*) were recovered from hunters at this location.

A total of 161 river dolphins was recorded (upriver counts) in the ~160 km section between the India-Nepal border (~5 km downriver of the Kosi Barrage) and Dhamara Ghat (Fungo Halt) during the survey (Choudhary and Dey 2019a, b).

Gharial Rescue

A sub-adult Gharial was rescued near Sitapur village (about 7 km south of Birpur) in March 2018 by a team from the Range Forest Office, Supaul Division. It was captured in the Sanjay Dhaa - a seepage channel (about 175 km long) that was part of a major avulsion of the Kosi River in 2008 (Fig. 5).

This location is ~22 km downriver from the point of the channel's 2008 avulsion and ~153 upriver of its confluence with the (present) main channel of the Kosi River; and 3 km upriver from the intersection of the Sanjay Dhaa with the Kosi Eastern main canal. It was released in the main channel of the Kosi near the 10th km spur (26.4474° N, 86.8981° E).



Figure 5. Rescued Gharial in back of a pick-up truck. Photograph: Suresh Prasad Gupta.

The Gharial was 6-7 ft long, and clipped tail scutes (double row, No. 6 left and No. 3 right) indicated that it was a reintroduced individual - likely No. 63, if in accordance with Bolton (1989) when considering (a) the point between the double row and single row of tail scutes to be zero, and (b) counting forwards towards the head, the double scutes represent tens on the left and units on the right.

Examination of photographs and video footage of the rescue and subsequent release suggest the individual to have been in good body condition - rounded neck, abdomen and base of the tail, and tail erect at rest. An injury (puncture wound) anterior to the left shoulder was reportedly inflicted by an arrow- or spear-like object, and was treated with a topical antiseptic application.

Discussion

Gharials were reportedly abundant in the Kosi River in the late-19th and early-20th centuries. Inglis (1892) mentions “*Going down the Koossee particularly, you came across hundreds sometimes lying on one bank*”, while Shortt (1921) writes of “*... an excellent stretch for both species, long and short snouters’ near Dhamarra ghat, and that the Sathar Dhar, a branch of the Kosi near Mokhama ghat, ... is simply full of crocodiles of both classes ...*”. The Kosi Gharial population was considerably depleted by the 1960s and 1970s, but continued to be reported from multiple locations along the river. Biswas (1970) records, from interviews with local residents, Gharials at Madhepura, Bakunia (near Nalhati), Gorodhar (near Gobiahi), 59th km near Namua, Lalgange (near Baluha), Dhamarghat, and the section from ‘Dhobighat to Karnaksthan of Nauhatta and Mahesi Block’. Shahi (1974) writes of the presence of Gharials in the Ganges and Gandak, but that “*... their main haunt continues to be the channel of the Kosi ...*” and “*... seen near Kursela, Dhamar ghat, Namua, Nauhatta and Mahesi in the Kosi area*”. It is not clear, however, if these are based on direct observations or secondary information.

There have been no confirmed reports of Gharials in the Kosi (India) since. No Gharials were recorded in a 2017 survey of the lower Kosi (not covered in the present survey), although local residents reported occasional sightings in the monsoon (WTI 2017), and the species was considered to have been extirpated here (Lang *et al.* 2019). Upriver in Nepal, Gharials were considered extinct in the Koshi by the

late-1970s (Maskey 1984 in Thapaliya *et al.* 2009). A total of 95 individuals were reintroduced in the Koshi between 1981 and 2010 (DNPWC 2018), although none are reported to have survived (Ibid.). Four Gharials were last recorded in the Koshi (Nepal) in 1998 (Thapaliya *et al.* 2009), and they were thought to no longer survive in the river (Goit and Basnet 2011; Shah and Paudel 2016; DNPWC 2018; Lang *et al.* 2019).

However, the report of an adult Gharial in 2008 in the marshes in Bhimnagar, Bihar (Goit and Basnet 2011), the 2018 rescue of a sub-adult Gharial near Sitapur, and our observations in January 2019 suggest that a few Gharials may continue to survive in the Kosi (Koshi) River System. The location of the 2008 Bhimnagar Gharial (Goit and Basnet 2011) corresponds to the Kosi eastern main canal, roughly 1.7 km downstream from its headworks, and this individual could only have arrived from the Koshi Tappu Wildlife Reserve in Nepal. The 2018 Sitapur Gharial (previous section) with clipped tail scutes is also in all likelihood from Nepal - the other, albeit remote, being an arrival from the Gandak via the Ganga - since we are not aware of any reintroductions in the Indian part of the Kosi. Similarly, reports of Gharials in the recent past from the Burhi Gandak (Singh 2017; Anon 2019) and Mahananda (Maitra 2015) Rivers adjacent to the Kosi, to the west and east respectively, indicate that other sites in Bihar may also harbour Gharials, and that detailed state-wide surveys can help assess their status and scope for conservation interventions.

Acknowledgements

We thank the Department of Environment, Forest and Climate Change, Government of Bihar (Supaul and Saharsa Divisions) for funding and logistic support; and, T.M. Bhagalpur University (Bhagalpur, Bihar) and Prof. Sunil K. Choudhary for facilitating the survey. Tarun Nair was supported by the Ashoka Trust for Research in Ecology and the Environment (Bangalore) and the CHANSE Project (Coupled Human and Natural Systems Environment for water management under uncertainty in the Indo-Gangetic Plain; NERC-MoES. NE/N01670X/1). We also thank Amit Kumar, Kanhaiya Kumar Das, Akshay Kumar and Balram Mukhiya for support in the field.

Literature Cited

Anonymous (2019). Three feet long crocodile found at Bariarpur Ghat, Forest Department left it at Rewa Ghat. Dainik Bhaskar, 28 November 2019 (<https://www.bhaskar.com/bihar/muzaffarpur/news/three-feet-long-crocodile-found-at-bariarpur-ghat-forest-department-left-it-at-rewa-ghat-101514-6048070.html>).

Biswas, S. (1970). A preliminary survey of gharial in the Kosi River. *The Indian Forester* 96(9): 705-710.

Bolton, M. (1989). *The Management of Crocodiles in Captivity*. FAO Conservation Guide 22. Food and Agriculture Organization of the United Nations: Rome.

Chakraborty, T., Kar, R., Ghosh, P. and Basu, S. (2010). Kosi megafan: Historical records, geomorphology and the recent avulsion of the Kosi River. *Quaternary International* 227(2): 143-160.

Choudhary, S.K. and Dey, S. (2019a). Final Report: Status of Ganges River Dolphins in Kosi River, Saharsa District, Bihar (April, 2018). Submitted to Saharsa Forest Division, Bihar. T.M. Bhagalpur University: Bhagalpur, Bihar, India.

Choudhary, S.K. and Dey, S. (2019b). Final Report: Status of Ganges River Dolphins in Kosi River in Supaul District, Bihar (2019). Submitted to Supaul Forest Division, Bihar. T.M. Bhagalpur University: Bhagalpur, Bihar, India.

DNPWC (2018). Gharial Conservation Action Plan for Nepal (2018-2022). Department of National Parks and Wildlife Conservation: Kathmandu, Nepal. 48 pp.

Gaurav, K., Métivier, F., Devauchelle, O., Sinha, R., Chauvet, H., Houssais, M. and Bouquerel, H. (2015). Morphology of the Kosi megafan channels. *Earth Surface Dynamics* 3: 321-331.

Goit, R.K. and Basnet, K. (2011). Status and conservation of crocodiles in the Koshi Tappu Wildlife Reserve, eastern Nepal. *Journal of Threatened Taxa* 3(8): 2001-2010.

Inglis, J. (1892). *Tent Life in Tigerland with which is incorporated Sport and Work on the Nepaul Frontier*. Sampson Low, Marston, and Company: London.

Lang, J.W., Chowfin, S. and Ross, J.P. (2019). *Gavialis gangeticus*. The IUCN Red List of Threatened Species 2019: e.T8966A3148543.

Maitra, S. (2015). Gharial rescued in Malda. *The Times of India*, 30 October 2015 (<https://timesofindia.indiatimes.com/city/kolkata/Gharial-rescued-in-Malda/articleshow/49588691.cms>).

Maskey, T.M. (1984). Survey of Gharial in Koshi, Kali Gandaki and Narayani Rivers in Nepal. DNPWC: Kathmandu, Nepal. 12 pp.

Shah, K.B. and Paudel, S. (2016). Ecology of crocodile and dolphin in the Koshi Basin. Pp. 123-128 *in* Connecting Flows and Ecology in Nepal: Current State of Knowledge of the Koshi Basin. Sustainable Development Investment Portfolio (SDIP) Project, ed. by T.M. Doody, S.M. Cuddy and L.D. Bhatta. CSIRO: Australia.

Shahi, S.P. (1974). Gharials (*Gavialis gangeticus*) and Marsh Crocodiles (*Crocodylus palustris*). *The Naturalist: Bulletin of the Bihar Natural History Society* 1(2): 3-5.

Shortt, W.H.O. (1921). A few hints on crocodile shooting. *Journal of the Bombay Natural History Society* 28: 76-84.

Singh, M. (2017). Magarmaxh in budhi gandak. <https://>

youtube/IVU0ltlAke8.

Sinha, R. (2008). The Great avulsion of Kosi on 18 August 2008. *Current Science* 97(3): 429-433.

Sinha, R., Gupta, A., Mishra, K., Tripathi, S., Nepal, S., Wahid, S.M. and Swarnkar, S. (2019). Basin-scale hydrology and sediment dynamics of the Kosi River in the Himalayan foreland. *Journal of Hydrology* 570: 156-166.

Thapaliya, B.P., Khadaka, M. and Kafley, H. (2009) Population Status and Distribution of Gharial (*Gavialis gangeticus*) in Nepal. *The Initiation (SUFFREC)*. 3: 11 pp.

WTI (2017). Recovery of Critically Endangered Gharial in the Gandak River. Progress Report, December 2016-June 2017, submitted to Department of Environment & Forests, Government of Bihar. Wildlife Trust of India. 25 pp.

Tarun Nair¹, Subhasis Dey² and Suresh Prasad Gupta³; ¹Ashoka Trust for Research in Ecology and the Environment, Royal Enclave, Jakkur Post, Srirampura, Bengaluru - 560064, India (tarunnair1982@gmail.com, tarun.nair@atree.org); ²Vikramshila Biodiversity Research & Education Centre, T.M. Bhagalpur University, Bhagalpur 812007, Bihar, India (subhasisvbrec98@gmail.com); ³Department of Environment, Forest and Climate Change, Range Forest Office, Supaul Division, Bihar, Government of Bihar, India.



Recent Publications

Grijalba, J., Forero, E., Contreras, A., Vargas, J. and Andrade, R. (2019). Determination of hematological values of common crocodile (*Caiman crocodilus fuscus*) in captivity in the North zone of Colombia. *Acta Biológica Colombiana* 25(1) (doi: <https://doi.org/10.15446/abc.v25n1.76045>).

Abstract: Caiman zoo breeding (*Caiman crocodilus fuscus*) has been developing with greater force in Colombia since the 90s. It is very important to evaluate the physiological ranges of the species to be able to assess those situations in which their health is threatened. The objective of the present study was to determine the normal hematological values of the common crocodile (*C. c. fuscus*) with the aid of the microhematocrit, the cyanometahemoglobin technique and a hematological analyzer. The blood samples were taken from 120 young animals both sexes in good health. The samples were taken from the coccygeal vein between the second and third interscalar space with lilac lid vacutainer tube. The animals are located in the middle of the Magdalena area in Colombia. The samples were transported and processed in the hematology laboratory of the Veterinary School of the Pedagogical and Technological University of Colombia. The results obtained on average were: Hematocrit: 23.36%, Hemoglobin: 7.78 g/dl, Red blood cells: 3.89 106/ μ L, Average corpuscular volume: 60 fl, Average corpuscular hemoglobin concentration: 33.33 g/dl and Average corpuscular hemoglobin: 73.9 pg. This is the first study of hematological values for this species in Colombia.

Woodyard, E.T., Baumgartner, W.A., Rush, S.A., Griffin, M.J. and

Rosser, T.G. (2019). Pathology associated with *Odhneriotrema incommodum* infection in wild-caught American alligators *Alligator mississippiensis* and assessment of potential first intermediate snail hosts. *Acta Parasitologica* (<https://doi.org/10.2478/s11686-019-00142-9>).

Abstract: Aims. To assess pathological changes associated with natural infections of the trematode *Odhneriotrema incommodum* in wild-caught American alligators *Alligator mississippiensis* and assess potential first intermediate hosts. **Materials and methods.** Tongues from two wild-caught alligators were obtained from a commercial alligator processor in Port Gibson, Mississippi, USA. Tongues were subjected to gross parasitological examination and routine histological assessment. Eggs were expressed from adult trematodes collected from these tongues into distilled water, where they hatched into infectious miracidia. The snails *Planorbella trivolvis*, *Physa gyrina*, and *Biomphalaria havanensis* were exposed to these miracidia and observed for cercarial emergence for 200 days post-exposure. **Results.** Histological assessment of alligator tongues revealed marked hemorrhage, necrosis, presence of bacteria, and inflammation at sites of *Odhneriotrema incommodum* attachment, differing from previous histological reports from controlled experimental studies. Cercarial emergence was not observed in snails exposed to infectious miracidia. **Conclusions.** Wild-caught alligators infected with *O. incommodum* exhibit more severe pathology than was previously noted from experimentally infected alligators. This adverse pathology may be associated with microbes present in eutrophic natural habitats that are absent from controlled environments used in experimental exposures. Impacts of this parasite in wild alligator populations are likely underestimated and damage associated with parasite attachment could increase host susceptibility to secondary infections. Given the importance of alligators as game animals and sustained demand for alligator products, further study into the role of *O. incommodum* on alligator health is warranted. Results of snail exposures to miracidia suggest these snail species are not suitable first intermediate hosts for this trematode and the true first intermediate host of *O. incommodum* remains unknown.

Jensen, B. and Christoffels, V.M. (2019). Reptiles as a model system to study heart development. *Cold Spring Harbor Perspectives in Biology* November 2019 11(11) (doi: [10.1101/cshperspect.a037226](https://doi.org/10.1101/cshperspect.a037226)).

Abstract: A chambered heart is common to all vertebrates, but reptiles show unparalleled variation in ventricular septation, ranging from almost absent in tuataras to full in crocodilians. Because mammals and birds evolved independently from reptile lineages, studies on reptile development may yield insight into the evolution and development of the full ventricular septum. Compared with reptiles, mammals and birds have evolved several other adaptations, including compact chamber walls and a specialized conduction system. These adaptations appear to have evolved from precursor structures that can be studied in present-day reptiles. The increase in the number of studies on reptile heart development has been greatly facilitated by sequencing of several genomes and the availability of good staging systems. Here, we place reptiles in their phylogenetic context with a focus on features that are primitive when compared with the homologous features of mammals. Further, an outline of major developmental events is given, and variation between reptile species is discussed.

Massonne, T., Vasilyan, D., Rabi, M. and Böhme, M. (2019). A new alligatoroid from the Eocene of Vietnam highlights an extinct Asian clade independent from extant *Alligator sinensis*. *PeerJ* 7: e7562.

Abstract: During systematic paleontological surveys in the Na Duong Basin in North Vietnam between 2009 and 2012, well-preserved fossilized cranial and postcranial remains belonging to at least 29 individuals of a middle to late Eocene [late Bartonian

to Priabonian age (39-35 Ma)] alligatoroid were collected. Comparative anatomical study of the material warrants the diagnosis of a new taxon, *Orientalosuchus naduongensis* gen. et sp. nov. The combined presence of an enlarged fifth maxillary tooth, prominent preorbital ridges, a large supraoccipital exposure on the skull table, a palatine-ptyergoid suture anterior to the posterior end of the suborbital fenestra, and a pterygoid forming a neck surrounding the choana is unique to this species. Unlike previous phylogenies, our parsimony analysis recovers a monophyletic Late Cretaceous to Paleogene East to Southeastern Asian alligatoroid group, here named Orientalosuchina. The group includes *Orientalosuchus naduongensis*, *Krabisuchus siamogallicus*, *Eoalligator chunyii*, *Jiangxisuchus nankangensis* and *Protoalligator huiningensis*, all of them sharing a medial shifted quadrate foramen aerum. The recognition of this clade indicates at least two separate dispersal events from North America to Asia: one during the Late Cretaceous by Orientalosuchina and one by the ancestor of *Alligator sinensis* during the Paleogene or Neogene, the timing of which is poorly constrained.

Dantas-Torres, F., Mascarenhas-Junior, P.B., Rodrigues dos Anjos, H., Maranhão dos Santos, E. and Sousa Correia, J.M. (2019). Tick infestation on caimans: a casual tick-host association in the Atlantic rainforest biome? Experimental and Applied Acarology (<https://doi.org/10.1007/s10493-019-00430-z>).

Abstract: Ticks are parasites of birds, mammals, amphibians, and reptiles, but information about tick communities that parasitize reptiles in the Neotropical region is still fragmentary. In the present study, we assessed the presence of ticks on broad-snouted caimans (*Caiman latirostris*) and Cuvier's dwarf caimans (*Paleosuchus palpebrosus*) trapped in the Atlantic rainforest biome in Pernambuco state, north-eastern Brazil, to determine which tick species feed on these animals and how frequent or rare this parasite-wildlife association is. We also report an occasional finding of *Amblyomma rotundatum* on a smooth-fronted caiman (*Paleosuchus trigonatus*) in the Amazon biome in Pará state, northern Brazil. Out of 490 animals trapped in the Atlantic rainforest biome, four (0.82%) broad-snouted caimans were infested by ticks. Ticks belonged to two *Amblyomma* species: *A. rotundatum* (three females) and *A. fuscum* (one male). Our findings indicate that ticks are infrequent parasites of caimans in the Atlantic rainforest biome. Tick infestation on broad-snouted caimans is probably of minor clinical significance and probably a casual finding due to habitat sharing with the common tick hosts.

Quintela, F.M., Pino, S.R., Silva, F.C., Loebmann, D., Costa, P.G., Bianchini, A. and Martins, S.E. (2019). Arsenic, lead and cadmium concentrations in caudal crests of the yacare caiman (*Caiman yacare*) from Brazilian Pantanal. Science of the Total Environment (<https://doi.org/10.1016/j.scitotenv.2019.135479>).

Abstract: Wetlands are environments of extreme importance due to their high biodiversity and invaluable ecosystem services. Nevertheless, wetlands worldwide are under the increasing threat of the effects of contaminants, which put at risk the biota and the ecosystems. Herein the concentrations of non-essential and toxic elements arsenic (As), lead (Pb) and cadmium (Cd) in caudal crests of the yacare caiman (*Caiman yacare*) from the Brazilian Pantanal, one of the largest wetlands in the world, were investigated aiming to compare concentrations in individuals from a large pristine area (Southern Pantanal) to animals from an area close to potential sources of anthropogenic emissions (Northern Pantanal). Levels above the limit of detection were found for all the elements in the majority of the analysed samples. The highest mean concentration was detected for As in samples from both sites, followed by Pb and Cd in samples from Southern Pantanal, and Cd and Pb in samples from Northern Pantanal. Significant negative correlations were found between As and Cd concentrations and the size of the individuals from the Southern Pantanal. Surprisingly, concentrations of all three elements were higher in pristine Southern Pantanal, but

with significant differences only for Cd. This result suggests that natural sources and processes may be acting for the mobilisation and availability of As, Pb and Cd for Southern Pantanal biota, which reflected in the contamination of *C. yacare*. Data from the literature showed higher levels of As, Pb and Cd in abiotic compartments in Southern Pantanal and adjacent plateaus in comparison to Northern Pantanal, corroborating the higher concentrations detected in biotic samples from the south. Thus, natural sources seem to play a relevant role in the contamination of biota by As, Pb and Cd in Southern Pantanal, characterising an intriguing pattern that could be tested for other species.

Azeez, O.I., Myburgh, J.G., Bosman, A.M., Featherston, J., Sibeko-Matjilla, K.P., Oosthuizen, M.C. and Chamunorwa, J.P. (2019). Next generation sequencing and RNA-seq characterization of adipose tissue in the Nile crocodile (*Crocodylus niloticus*) in South Africa: Possible mechanism(s) of pathogenesis and pathophysiology of pansteatitis. PLoS One 14(11): e0225073.

Abstract: Background: Concerted efforts to identify the pathogenesis and mechanism(s) involved in pansteatitis, (a generalized inflammation of the adipose tissue), that was attributed to the recent crocodile die off in the Olifants River and Loskop Dam in Kruger National Park, Mpumalanga, South Africa have been in the forefront of research in recent time. As part of the efforts, molecular characterization of healthy and pansteatitis adipose tissue was carried out by RNA sequencing (RNA-Seq) using Next Generation Sequencing (NGS) and de novo assembly of the adipose transcriptome, followed by differential gene expression analysis. **Methodology:** Healthy adipose tissue consisting of 50 samples was collected from the subcutaneous, visceral, intermuscular adipose tissues and the abdominal fat body of 10 4-year-old juvenile crocodiles from a local crocodile farm in Pretoria, South Africa. Ten pansteatitis samples were collected from visceral and intermuscular adipose tissues of five crocodiles that were dying of pansteatitis. **Results:** Forty-two thousand, two hundred and one (42,201) transcripts were assembled, out of which 37,835 had previously been characterized. The de novo assembled transcriptome had an N50 (average sequence) of 436 bp, percentage GC content of 43.92, which compared well with previously assembled transcripts in the saltwater crocodile. Seventy genes were differentially expressed and upregulated in pansteatitis. These included genes coding for extracellular matrix (ECM) signaling ligands, inflammatory cytokines and tumour necrosis factor alpha (TNFα) receptors, fatty acid synthase and fatty acid binding proteins, peroxisome proliferator-activated receptor gamma (PPARγ), nuclear factor and apoptosis signaling ligands, and mitogen activated protein kinase enzymes among others. Majority (88.6%) of the upregulated genes were found to be involved in hypoxia inducible pathways for activation of NFκβ and inflammation, apoptosis, Toll-like receptor pathway and PPARγ. Bicaudal homologous 2 Drosophila gene (BICD2) associated with spinal and lower extremity muscle atrophy was also upregulated in pansteatitis while Sphingosine-1-phosphate phosphatase 2 (SGPP2) involved in Sphingosine-1-phosphate metabolism was downregulated. Furthermore, Doublesex-mab-related transcription factor 1 (DMRT1) responsible for sex gonad development and germ cell differentiation was also downregulated. **Conclusion:** Thus, from the present study, based on differentially expressed genes in pansteatitis, affected Nile crocodiles might have died partly due to their inability to utilize stored triglycerides as a result of inflammation induced insulin resistance, leading to starvation in the midst of plenty. Affected animals may have also suffered muscular atrophy of the lower extremities and poor fertility.

Gonzalez-Jauregui, M., Borges-Ramirez, M., Barão-Nóbrega, J.A.L., Escamilla, A., Dzul-Caamal, R. and Rendón-von Ostena, J. (2019). Stomach flushing technique applied to quantify microplastics in crocodilians. MethodsX (<https://doi.org/10.1016/j.mex.2019.11.013>).

Abstract: The impact of microplastics on wildlife is a recent problem for which methods to evaluate exposure still need development. Being able to identify and quantify microplastics (particles < 5 mm) in the gastric contents of live crocodiles allows us to evaluate exposure, at both individual and population level, and also its contribution as transporter of other contaminants. The method was validated to determine and quantify microplastics in crocodile stomach contents recovered during an experiment where a known amount of this contaminant was given to crocodiles via oral administration. Through stomach flushing we were able to recover more than 80 % of the total volume of microplastic administered to each crocodile. In summary, the method used during the experiment consists of 1) immobilization of the crocodile; 2) extraction of microplastics from stomach contents obtained through stomach flushing; 3) separation, identification and quantification of recovered microplastic fragments using microscopy and FTIR.

- Low cost method that uses a small number of materials, does not take long to produce results and can easily be performed in the field or the laboratory.
- Effective in extracting stomach contents (95 %).
- High (>80 %) and good (>60 %) recovery efficiencies within two and four days after ingestion of microplastics by crocodiles



Bolaños Montero, J.R., Sánchez Ramírez, J.J., Sigler, L., Barr, B.R. and Sandoval Hernández, I. (2019). Population status of the American crocodile, *Crocodylus acutus* (Reptilia: Crocodylidae) and the caiman, *Caiman crocodilus* (Reptilia: Alligatoridae), in the Central Caribbean of Costa Rica. *Revista de Biología Tropical* 67(6): 1180-1193.

Abstract: Two species of crocodylians have been described in Costa Rica, American crocodile, *Crocodylus acutus* (Cuvier, 1807), and caiman, *Caiman crocodilus* (Linnaeus 1758). In Costa Rica, data has been generated on both species, but populations in the Pacific have received more attention from researchers; presumably due to the fact that the Pacific slope has a greater development, which brings greater social pressure on the attention of the incidents generated by the encounter between humans and crocodiles. This study, performed during 2017, was done in an area of approximately 400 km², characterized by having a wide and dense network of watercourses, which includes the Matina, Pacuare, Reventazón and Parismina rivers. In these rivers, an average of 25 km were traveled from the coastline up stream to the interior of the territory, including the Tortuguero canals, and other water bodies that connect these rivers, as well as in the most important lagoons and secondary channels. Three repetitions were made per segment. A population of 1084 caimans and 503 crocodiles is estimated; for a sight count of 8.64 and 2.80 ind/km respectively. Speaking of caimans, up to 12% of individuals of reproductive age were observed, while for crocodiles that number was only 2 %. The abundance of both species in the different places studied, turned out to be significantly different for crocodiles and for caimans (Kruskal-Wallis, $P \leq 0.001$). Likewise, the size distribution is similar for crocodiles reported in all environments (Kruskal-Wallis, $p \leq 0.15$), while for caimans it indicates that there is a different distribution for sizes, according to the environment in which they are found (Kruskal-Wallis, $P \leq 0.001$), with a bias against of the Pacuare and Matina Rivers. It was possible to estimate a sex ratio of 1.25 and 0.83 males to females, in crocodiles and caimans respectively, with 9 and 11 captures in that same order, in recruit and

juvenile sizes.

Berjola, G. (2019). Lautreámont et Louis-Claude de Saint-Martin. Les confidences d'un crocodile. *Cahiers Lautreámont* 1: 179-194.

Abstract: Le crocodile, symbole du mal et du mensonge, apparaît sous la plume de Ducasse. S'agit-il d'une réminiscence d'un obscur ouvrage de Louis-Claude de Saint-Martin, épopée en prose et en vers où le bien et le mal s'affrontent comme des allégories du débat spiritualisme versus matérialisme au xviii^e siècle ? À travers la figure du crocodile, Ducasse exploite la métaphore du langage comme un poison.

[Editor's translation: The crocodile, symbol of evil and lies, appears under the pen of Ducasse. Is it a reminiscence of an obscure work by Louis-Claude de Saint-Martin, epic in prose and verse where good and evil clash as allegories of the debate spiritualism versus materialism in the 18th century? Through the figure of the crocodile, Ducasse exploits the metaphor of language as a poison.]

Montefeltro, F.C., Lautenschlager, S., Godoy, P.L., Ferreira, G.S. and Butler, R.J. (2019). A unique predator in a unique ecosystem: modelling the apex predator from the Late Cretaceous crocodyliform-dominated fauna in Brazil. *BioRxiv* (<http://dx.doi.org/10.1101/843334>).

Abstract: Theropod dinosaurs were relatively scarce in the Late Cretaceous ecosystems of southeast Brazil. Instead, the abundant hypercarnivore crocodyliforms known as baurusuchids were probably playing the ecological role as apex predators. Baurusuchids exhibited a series of morphological adaptations associated to this ecological role, but quantitative biomechanical assessments to support this were lacking to date. Here, we employ a biomechanical modelling approach, using finite element analysis (FEA) on skull and mandible models of a baurusuchid specimen, allowing us to characterise the craniomandibular apparatus of baurusuchids, as well as to test the hypothesis that their functional morphology allowed them to outcompete other carnivores, such as theropods. Our results demonstrate, for the first time, the ecological role of this group as specialised apex predators in the continental Late Cretaceous ecosystems of South America. With a relatively weak bite force (~600 N), baurusuchids preying strategies probably relied on other morphological specializations, such as ziphodont dentition and strong cervical musculature. Consistently, comparative assessments of the stress distribution and magnitude of scaled models of other predators (the theropod *Allosaurus fragilis* and the living crocodylian *Alligator mississippiensis*) show discrepant responses to loadings under the same functional scenarios, further suggesting considerably distinct predatory behaviors for these animals. The unique selective pressures from the arid to semi-arid Late Cretaceous palaeoecosystems of southeast Brazil, which were dominated by crocodyliforms, possibly drove the emergence and evolution of such exclusive set of biomechanical features seen in baurusuchids, which had not been previously reported for any other predatory taxon.

Quintela, F.M., Pino, S.R., Silva, F.C., Loebmann, D., Costa, P.G., Bianchini, A. and Martins, S.E. (2019). Arsenic, lead and cadmium concentrations in caudal crests of the yacare caiman (*Caiman yacare*) from Brazilian Pantanal. *Science of the Total Environment* (<https://doi.org/10.1016/j.scitotenv.2019.135479>).

Abstract: Wetlands are environments of extreme importance due to their high biodiversity and invaluable ecosystem services. Nevertheless, wetlands worldwide are under the increasing threat of the effects of contaminants, which put at risk the biota and the ecosystems. Herein the concentrations of non-essential and toxic elements arsenic (As), lead (Pb) and cadmium (Cd) in caudal crests of the yacare caiman (*Caiman yacare*) from the Brazilian Pantanal,

one of the largest wetlands in the world, were investigated aiming to compare concentrations in individuals from a large pristine area (Southern Pantanal) to animals from an area close to potential sources of anthropogenic emissions (Northern Pantanal). Levels above the limit of detection were found for all the elements in the majority of the analysed samples. The highest mean concentration was detected for As in samples from both sites, followed by Pb and Cd in samples from Southern Pantanal, and Cd and Pb in samples from Northern Pantanal. Significant negative correlations were found between As and Cd concentrations and the size of the individuals from the Southern Pantanal. Surprisingly, concentrations of all three elements were higher in pristine Southern Pantanal, but with significant differences only for Cd. This result suggests that natural sources and processes may be acting for the mobilisation and availability of As, Pb and Cd for Southern Pantanal biota, which reflected in the contamination of *C. yacare*. Data from the literature showed higher levels of As, Pb and Cd in abiotic compartments in Southern Pantanal and adjacent plateaus in comparison to Northern Pantanal, corroborating the higher concentrations detected in biotic samples from the south. Thus, natural sources seem to play a relevant role in the contamination of biota by As, Pb and Cd in Southern Pantanal, characterising an intriguing pattern that could be tested for other species.

McClain, C.R., Nunnally, C., Dixon, R., Rouse, G.W. and Benfield, M. (2019). Alligators in the abyss: The first experimental reptilian food fall in the deep ocean. *PLoS ONE* 14(12): e0225345.

Abstract: The high respiration rates of the deep-sea benthos cannot be sustained by known carbon supply pathways alone. Here, we investigate moderately-sized reptilian food falls as a potential alternative carbon pathway. Specifically, three individual carcasses of *Alligator mississippiensis* were deployed along the continental slope of the northern Gulf of Mexico at depths of ~2000 m in early 2019. We posit the tough hide of alligators would impeded scavengers by limiting access to soft tissues of the alligator fall. However, the scavengers began consuming the food fall 43 hours post-deployment for one individual (198.2 cm, 29.7 kg), and the carcass of another individual (175.3 cm, 19.5 kg) was completely devoid of soft tissue at 51 days post-deployment. A third individual (172.7 cm, 18.5 kg) was missing completely after 8 days, with only the deployment harness and weight remaining 8 m away, suggesting a large elasmobranch scavenger. Additionally, bones recovered post-deployment reveal the first observations of the bone-eating *Osedax* in the Gulf of Mexico and are confirmed here as new to science. The findings of this study indicate the quick and successful utilization of terrestrial and aquatic-based carbon food sources in the deep marine environment, though outcome variability may be high.

Sulcova, M.L., Zahradnicek, O., Dumkova, J., Dosedelova, H., Krivanek, J., Hampl, M., Kavkova, M., Zikmund, T., Gregorovicova, M., Sedmera, D., Kaiser, J., Tucker, A.S. and Buchtova, M. (2019). Developmental mechanisms driving complex tooth shape in reptiles. *Developmental Dynamics* (<https://doi.org/10.1002/dvdy.138>).

Abstract: In mammals, odontogenesis is regulated by transient signaling centers known as enamel knots (EKs), which drive the dental epithelium shaping. However, the developmental mechanisms contributing to formation of complex tooth shape in reptiles are not fully understood. Here, we aim to elucidate whether signaling organizers similar to EKs appear during reptilian odontogenesis and how enamel ridges are formed. Morphological structures resembling the mammalian EK were found during reptile odontogenesis. Similar to mammalian primary EKs, they exhibit the presence of apoptotic cells and no proliferating cells. Moreover, expression of mammalian EK-specific molecules (SHH, FGF4, and ST14) and GLI2-negative cells were found in reptilian EK-like areas. 3D analysis of the nucleus shape revealed distinct rearrangement of the cells associated with enamel groove formation.

This process was associated with ultrastructural changes and lipid droplet accumulation in the cells directly above the forming ridge, accompanied by alteration of membranous molecule expression (Na/K-ATPase) and cytoskeletal rearrangement (F-actin). The final complex shape of reptilian teeth is orchestrated by a combination of changes in cell signaling, cell shape, and cell rearrangement. All these factors contribute to asymmetry in the inner enamel epithelium development, enamel deposition, ultimately leading to the formation of characteristic enamel ridges.

Gandar, F., Schmidt-Ukaj, S., Bogan, J. and Marschang, R.E. (2019). "What's New in the Scientific Literature Infectious Diseases of Reptiles and Amphibians: Peer-reviewed publications, January-July 2019". *Journal of Herpetological Medicine and Surgery* 29(3-4): 63-70.

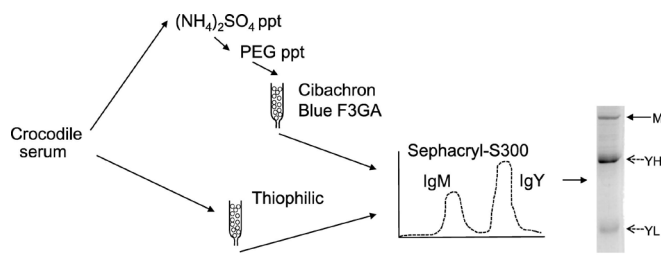
Buenfil-Rojasa, A.M., Alvarez-Legorreta, T., Cedeño-Vazquez, J.R., Rendón-von Osten, J. and González-Jáuregui, M. (2020). Distribution of metals in tissues of captive and wild Morelet's crocodiles and the potential of metallothioneins in blood fractions as a biomarker of metal exposure. *Chemosphere* 244 (<https://doi.org/10.1016/j.chemosphere.2019.125551>).

Abstract: The distribution of Hg, Cd, Cu, and Zn in keratinized tissues, blood fractions, and excretory organs, and MTs in blood fractions and excretory organs was determined in captive, semicaptive, and wild Morelet's crocodiles and they were compared to select the most useful non-destructive tissues for the monitoring of metal exposure and to assess the potential of MTs as a biomarker. Our results indicate blood plasma, claws, and caudal scutes altogether are suitable tissues for xenobiotic metals exposure, with concentrations in blood plasma being an indicator of recent exposure, whereas concentrations in claws and caudal scutes are indicators of chronic exposure. Results in keratinized tissues suggest they are an important detoxification strategy in crocodiles, and claws presented the highest concentrations of metals in both captive (Hg= 0.44 ± 0.23 µg g⁻¹, Cd= 11.10 ± 5.89 µg g⁻¹, Cu= 45.98 ± 23.18 µg g⁻¹, Zn= 124.75 ± 75.84 µg g⁻¹) and wild populations (Hg= 1.31 ± 0.32 µg g⁻¹, Cd= 26.47 ± 21.15 µg g⁻¹, Cu= 191.75 ± 165.91 µg g⁻¹, Zn= 265.81 ± 90.62 µg g⁻¹). Thus, they are an appropriate tool for assessing metal exposure in populations where scutes clipping as a marking technique is not allowed, and their collection is less complicated than with other tissues. MTs are a suitable biomarker in blood plasma, whereas in erythrocytes detoxification processes might depend on hemoglobin, rather than MTs. Future studies should consider the implementation of these tools for the monitoring of wild populations.

Abdool, F.S., Coetzer, T.H.T. and Goldring, J.P.D. (2019). Isolation of Nile crocodile (*Crocodylus niloticus*) serum immunoglobulin M and Y (IgM and IgY). *Journal of Immunological Methods* (<https://doi.org/10.1016/j.jim.2019.112724>).

Abstract: Crocodile immunity has not been fully characterised with more studies on crocodile innate immunity than cell-mediated or humoral immunity. Crocodile immunoglobulin genes have been described but immunoglobulin proteins have not been isolated or studied biochemically. Two large proteins proposed to be crocodile IgM and IgY were isolated and purified from *Crocodylus niloticus* sera using two different protocols. A 50% (w/v) ammonium sulfate and a 15% (w/v) polyethylene glycol precipitation step was followed by Cibacron blue F3GA affinity- and Sephacryl-S300 gel filtration chromatography. An alternate purification protocol, with only two steps, involved thiophilic affinity- and Sephacryl-S300 gel filtration chromatography. The purified crocodile IgM resolved on reducing SDS-PAGE with an apparent mass of 180 kDa. Purified crocodile IgY resolved at 180 kDa alongside chicken IgY on a non-reducing SDS-PAGE gel, and is deduced to consist of two 66 kDa heavy and two 23 kDa light chains under reducing conditions. The thiophilic/gel

filtration two-step protocol gave three-fold higher yields of isolated protein than the four-step precipitation/chromatography protocol. Antibodies against the isolated crocodile IgM and IgY were raised in chickens and affinity purified. The chicken antibodies differentiated between crocodile IgM and IgY and have the potential for use in the diagnosis of crocodile infections. The purified crocodile antibodies can be biochemically characterised and compared to mammalian and avian antibodies to give a better understanding of crocodile humoral immunity.



Vyas, R. and Vasava, A. (2019). Mugger crocodile (*Crocodylus palustris*) mortality Due to roads and railways in Gujarat, India. *Herpetological Conservation and Biology* 14(3): 615-626.

Abstract: An extensive network of roads and railways cuts across the Indian landscape, resulting in vehicle collisions with a variety of wildlife. A frequent victim of these collisions is the Mugger Crocodile (*Crocodylus palustris*). Of the 38 crocodile-vehicle collisions (CVC) recorded between 2005 and 2018, 24 were on roads and 14 were on railway tracks. Sex was determined for 23 individuals (10 males, 13 females, 15 unknown). Twenty-nine individuals were found dead at the site of collisions, four individuals died while undergoing medical treatment, and five were treated successfully and returned to wild. The majority of collisions occurred in Vadodara, central Gujarat, India. There has been a rise in CVC in the last decade, wherein only four CVC were reported between 2005 and 2010, which rose to 34 in the following 8 years (2011-2018). Length of Muggers involved in collisions ranged from 60-320 cm total length (TL), with higher number of collisions recorded for juvenile and sub-adult individuals ($n=24, \leq 180$ cm TL), compared to adult individuals ($n=12, >180$ cm TL). The frequency of collisions was higher in the monsoon months (July-October; 71%), with very few in the winter (November-February; 21%), and summer (March-June; 8%). Mitigation measures for the collision situation in Gujarat are discussed.

Prystupczuk, L., Leynaud, G.C. and Labaque, M.C. (2019). Evaluating behavior and enclosure use of zoo-housed Broad-snouted caiman (*Caiman latirostris*): A case study in the zoo of Córdoba (Argentina). *Herpetological Conservation and Biology* 14(3): 601-614.

Abstract: Zoo environments represent a useful opportunity for animal research, particularly for species that are difficult to observe in the wild. Moreover, studying the behavior of zoo-housed populations provides important information about the welfare state of animals. We described the behaviors of a zoo-housed population of seven Broad-snouted Caimans (*Caiman latirostris*) composed of males and females of different ages. We evaluated the associations of behavior frequencies with attributes of individuals (sex and age class) and with environmental variables (season, time of the day, and daily mean temperature). We calculated the Spread of Participation Index to estimate the use of space in relation to attributes of individuals and environmental variables. Additionally, we evaluated the suitability of the enclosure and management measures by assessing the Five Freedoms. The results showed higher frequencies of aquatic behaviors in adults than in subadults, which may reflect an ontogenetic shift in behavior or, conversely, may be a consequence of a dominance hierarchy. There were almost no differences in behavior frequencies between sexes. Aquatic behaviors were associated with lower temperatures, which could be

attributed to thermoregulation. The results also showed daily movements from water in the morning to land at midday and in the afternoon. A high rate of agonistic behaviors was recorded, and possible causes and implications are discussed. Enclosure use was low, with some zones being poorly used or not used at all, and with marked variability among individuals. Finally, 53% of the husbandry recommendations for this species were met in the study population.

Murray, C.M., Crother, B.I. and Doody, J.S. (2019). The evolution of crocodilian nesting ecology and behavior. *Ecology and Evolution* (DOI: 10.1002/ece3.5859).

Abstract: Crocodilians comprise an ancient and successful lineage of archosaurs that repeatedly raises questions on how they survived a mass extinction and remained relatively unchanged for ~100 million years. Was their success due to the change-resistant retention of a specific set of traits over time (phylogenetic conservatism) or due to flexible, generalist capabilities (eg catholic diets, phenotypic plasticity in behavior), or some combination of these? We examined the evolution of reproductive ecology and behavior of crocodilians within a phylogenetic perspective, using 14 traits for all 24 species to determine whether these traits were phylogenetically constrained versus (ecologically) convergent. Our analysis revealed that the ancestral crocodilian was a mound nester that exhibited both nest attendance and defense. Nesting mode exhibited 4-5 transformations from mound to hole nesting, a convergence of which habitat may have been a driving factor. Hole nesters were more likely to nest communally, but this association may be biased by scale. Although there were exceptions, mound nesters typically nested during the wet season and hole nesters during the dry season; this trait was relatively conserved, however. About two-thirds of species timed their nesting with the wet season, while the other third timed their hatching with the onset of the wet season. Nest attendance and defense were nearly ubiquitous and thus exhibited phylogenetic conservatism, but attendance lodging was diverse among species, showing multiple reversals between water and burrows. Collectively, our analysis reveals that reproductive trait evolution in crocodilians reflects phylogenetic constraint (nest attendance, nest defense), ecological convergence (seasonal timing of nesting, nest attendance lodging), or both (mode of nesting). Some traits (eg communal nesting and mode of nesting) were autocorrelated. Our analysis provides a framework for addressing hypotheses raised for why there has been trait convergence in reproductive ecology and behavior in crocodilians and why some traits remained phylogenetically conserved.

Nilsen, F.M., Rainwater, T.R., Wilkinson, P.M., Brunell, A.M., Lowers, R.H., Bowden, J.A., Guillette, L.J., Long, S.E. and Schock, T.B. (2020). Examining maternal and environmental transfer of mercury into American alligator eggs. *Ecotoxicology and Environmental Safety* 189 (https://doi.org/10.1016/j.ecoenv.2019.110057).

Abstract: American alligators are exposed to mercury (Hg) throughout their natural range and may maternally transfer Hg into their eggs. Wildlife species are highly sensitive to Hg toxicity during embryonic development and neonatal life, and information on Hg transfer into eggs is critical when attempting to understand the effects of Hg exposure on developing oviparous organisms. To examine Hg transfer in alligators, the objectives of the present study were to 1) determine Hg concentrations in yolk (embryonic and neonatal food source) from wild alligator eggs collected from three locations - Yawkey Wildlife Center SC (YWC), Lake Apopka FL (LA), and Lake Woodruff FL (LW); 2) examine the relationship between THg concentrations in wild alligator nest material and egg yolk at Merritt Island National Wildlife Refuge, FL; 3) examine the Hg concentrations in wild maternal female alligators (blood) and the THg in corresponding egg yolks and embryos across three nesting seasons at a single location (YWC), and evaluate the relationship between nesting female THg concentrations (blood) and their

estimated age and number of nesting years (YWC); and 4) assess the transfer of biologically-relevant Hg concentrations (based on Hg measured in maternal female blood) into embryos using an egg-dosing experiment. Mean total Hg (THg) concentrations observed at each site were 26.3 ng/g \pm 11.0 ng/g (YWC), 8.8 ng/g \pm 5.1 ng/g (LA), and 22.6 ng/g \pm 6.3 ng/g (LW). No relationship was observed between THg in alligator nest material and corresponding yolk samples, nor between THg in maternal alligator blood and estimated age and number of nesting years of these animals. However, significant positive relationships were observed between THg in blood of nesting female alligators and THg in their corresponding egg yolk. We observed that 12.8% of the maternal blood THg is found in the corresponding egg yolk, and a highly significant correlation was observed between the two sample types ($r = 0.66$; $p < 0.0001$). The egg dosing experiment revealed that Hg did not transfer through the eggshell at developmental stage 19. Overall, this study provides new information regarding Hg transfer in American alligators which can improve biomonitoring efforts and may inform ecotoxicological investigations and population management programs in areas of high Hg contamination.

Alderson, D. (2020). *America's Alligator: A Popular History of Our Most Celebrated Reptile*. The Rowman and the Littlefield Publishing Group: Lanham.

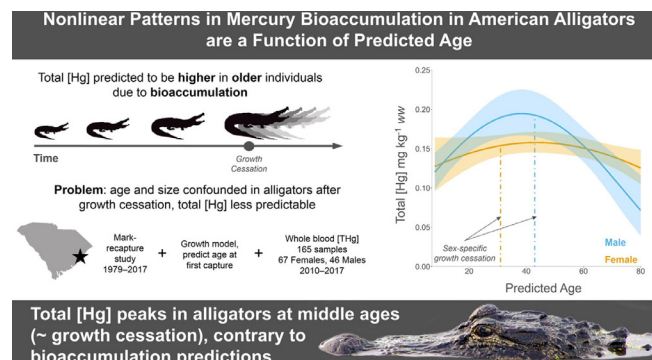
Balaguera-Reina, S.A. (2019). Rediscovering the Apaporis Caiman (*Caiman crocodilus apaporiensis*): Notes from a long-anticipated expedition. *Journal of Herpetology* 53(4): 310-315.

Abstract: *Caiman crocodilus apaporiensis* has been of particular interest because of its clearly differentiated morphotype within the Spectacled Caiman complex. Information on the biology of *C. c. apaporiensis* is incomplete because of its restricted distribution in the inaccessible middle and upper Apaporis River in Colombia. I undertook an expedition to the middle Apaporis River basin in an attempt to validate the presence of *C. c. apaporiensis* through observations on morphometry, ecology, and ethnozoology. Previously described skull characteristics were clearly differentiable in both adults and subadults in the region. However, because many individual *C. c. apaporiensis* that were either captured or visually assessed were relatively small, some skull characteristics more closely resembled the more general *C. crocodilus* morphotype. Although data on population size and distribution of *C. c. apaporiensis* remain limited, information gleaned from local inhabitants indicates that the subspecies is common in the middle Apaporis River. Population parameter and molecular phylogeography studies could lead to management practices that would protect the genetic integrity of *C. c. apaporiensis* by minimizing subspecific interbreeding.

Lawson, A.J., Moore, C.T., Rainwater, T.R., Nilsen, F.M., Wilkinson, P.M., Lowers, R.H., Guillette, Jr., L.J., McFadden, K.W. and Jodice, P.G.R. (2019). Nonlinear patterns in mercury bioaccumulation in American alligators are a function of predicted age. *Science of the Total Environment* (<https://doi.org/10.1016/j.scitotenv.2019.135103>).

Abstract: Mercury is a widespread, naturally occurring contaminant that biomagnifies in wetlands due to the methylation of this element by sulfate-reducing bacteria. Species that feed at the top trophic level within wetlands are predicted to have higher mercury loads compared to species feeding at lower trophic levels and are therefore often used for mercury biomonitoring. However, mechanisms for mercury bioaccumulation in sentinel species are often poorly understood, due to a lack of long-term studies or an inability to differentiate between confounding variables. We examined mercury bioaccumulation patterns in the whole blood of American alligators (*Alligator mississippiensis*) from a long-term mark-recapture study (1979-2017) in South Carolina, USA. Using a growth model and auxiliary information on predicted age at first capture, we differentiated between age- and size-related variation in mercury

bioaccumulation, which are often confounded in alligators due to their determinate growth pattern. Contrary to predictions that the oldest or largest individuals were likely to have the highest mercury concentrations, our best-supported model indicated a peak in mercury concentration at 30-40 years of age, depending on the sex, and lower concentrations in the youngest and oldest animals.



To evaluate the robustness of our findings, we re-analyzed data from a previously published study of mercury in alligators sampled at Merritt Island National Wildlife Refuge in Florida. Unlike the South Carolina data, the data from Florida contained minimal auxiliary information regarding age, yet the best supported model similarly indicated a peaked rather than increasing relationship between mercury and body size, a less-precise indicator of age. These findings highlight how long-term monitoring can differentiate between confounding variables (eg age and size) to better elucidate complex relationships between contaminant exposure and demographic factors in sentinel species.

Solórzano, A., Núñez-Flores, M., Inostroza-Michael, O. and Hernández, C.E. (2019). Biotic and abiotic factors driving the diversification dynamics of Crocodylia. *Palaeontology* (<https://doi.org/10.1111/pala.12459>).

Abstract: Species diversity patterns are governed by complex interactions among biotic and abiotic factors over time and space, but are essentially the result of the diversification dynamics (differential speciation and extinction rates) over the long-term evolutionary history of a clade. Previous studies have suggested that temporal variation in global temperature drove long-term diversity changes in Crocodylia, a monophyletic group of large ectothermic organisms. We use a large database of crocodylian fossil occurrences (192 spp.) and body mass estimations, under a taxic approach, to characterize the global diversification dynamics of crocodylians since the Cretaceous, and their correlation with multiple biotic and abiotic factors in a Bayesian framework. The diversification dynamic of crocodylians, which appears to have originated in the Turonian (c. 92.5 Ma), is characterized by several phases with high extinction and speciation rates within a predominantly low long-term mean rate. Our results reveal long-term diversification dynamics of Crocodylia to be a highly complex process driven by a combination of biotic and abiotic factors which influenced the speciation and extinction rates in dissimilar ways. Higher crocodylian extinction rates are related to low body mass disparity, indicating selective extinctions of taxa at both ends of the body mass spectrum. Speciation rate slowdowns are noted when the diversity of the clade is high and the warm temperate climatic belt is reduced. Our finding supports the idea that temporal variations of body mass disparity, self-diversity, and the warm climate belt size provided more direct mechanistic explanations for crocodylian diversification than do proxies of global temperature.

Brown, E.E., Butler, R.J., Ezcurra, M.T., Bhullar, B.-A.S. and Lautenschlager, S. (2019). Endocranial anatomy and life habits of the Early Triassic archosauriform *Proterosuchus fergusi*. *Palaeontology* (<https://doi.org/10.1111/pala.12454>).

Abstract: Proterosuchids are an important group of carnivorous basal archosauriforms characterized by a bizarre and enigmatic downturned premaxilla that overhangs the lower jaw. They are particularly significant because they radiated in the immediate aftermath of the Permian–Triassic mass extinction and represent one of the best known ‘disaster taxa’ following that event. While traditionally considered to be semi-aquatic, recent histological studies and geological data have suggested that it is more likely that they inhabited terrestrial environments. By using computed tomographic (CT) data, we virtually reconstruct the brain endocast and endosseous labyrinths of two adult specimens of *Proterosuchus fergusi* from the earliest Triassic of South Africa, in an attempt to understand its life habits within the context of basal archosauriform evolution. Endocasts reveal that the brain cavity is tubular in shape and the endosseous labyrinths are highly pyramidal. The angle of the lateral semicircular canal suggests that *P. fergusi* naturally held its head upwards $\sim 17^\circ$, while the length of the cochlear duct suggests its auditory abilities were specialized towards low-frequency sounds. Furthermore, beam theory analysis suggests that the rostrum of *P. fergusi* is highly resistant to both bending and torsion when compared to modern crocodylians, although this resistance is neither enhanced nor reduced by the overhanging premaxilla. Comparative anatomical analyses suggest *P. fergusi* was probably a semi-aquatic, generalist apex predator capable of surviving the harsh environmental perturbations of the Early Triassic.

Dudgeon, T.W. (2019). The Internal Cranial Anatomy of *Champsosaurus lindoei* and its Functional Implications. MSc thesis, Carleton University, Ottawa, Ontario, Canada.

Abstract: Although *Champsosaurus* is well-known in Late Cretaceous and Paleocene deposits of North America, their cranial anatomy is poorly understood. Here, a wellpreserved skull of *Champsosaurus lindoei* is described in detail using high-resolution micro-CT scanning. This confirms the presence of the putative neomorphic bone, which may be homologous with the pre-existing stapes, or developed through incomplete fusion of dermatocranial ossification centres. The ventral openings on the skull of *Champsosaurus* relate to the fenestrae ovals, an unusual configuration that may be convergent with other aquatic reptiles. Overall, the endocranial anatomy of *Champsosaurus* is typical for a basal diapsid. The morphology of the pars inferior of the inner ear suggests that *Champsosaurus* were capable of detecting sound underwater, and geometric morphometric analyses of the semicircular canals suggests that they were specialized for detecting head movements in an aquatic environment. Taken together, these results suggest that *Champsosaurus* were well adapted for an aquatic lifestyle.

Van Asch, B., Versfeld, W.F., Hull, K.L., Leslie, A.J., Matheus, T.I., Beytell, P.C., du Preez, P., Slabbert, R. and Rhode, C. (2019). Phylogeography, genetic diversity, and population structure of Nile crocodile populations at the fringes of the southern African distribution. PLoS One 14(12): e0226505.

Abstract: Nile crocodiles are apex predators widely distributed in sub-Saharan Africa that have been viewed and managed as a single species. A complex picture of broad and fine-scale phylogeographic patterns that includes the recognition of two species (*Crocodylus niloticus* and *Crocodylus suchus*), and the structuring of populations according to river basins has started to emerge. However, previous studies surveyed a limited number of samples and geographical regions, and large areas of the continent remained unstudied. This work aimed at a fine scale portrait of Nile crocodile populations at the fringes of their geographic distribution in southern Africa. Wild and captive individuals were sampled across four major river systems (Okavango, Lower Kunene, Lower Shire and Limpopo) and the KwaZulu-Natal region. A multi-marker approach was used to infer phylogeographic and genetic diversity patterns, including new and public mitochondrial data, and a panel of 11 nuclear

microsatellites. All individuals belonged to a phylogenetic clade previously associated with the *C. niloticus* species, thus suggesting the absence of *C. suchus* in southern Africa. The distribution of mitochondrial haplotypes indicated ancestral genetic connectivity across large areas, with loss of diversity along the north-south axis. Genetic variation partitioned the populations primarily into western and eastern regions of southern Africa, and secondarily into the major river systems. Populations were partitioned into five main groups corresponding to the Lower Kunene, the Okavango, the Lower Shire, and the Limpopo rivers, and the KwaZulu-Natal coastal region. All groups show evidence of recent bottlenecks and small effective population sizes. Long-term genetic diversity is likely to be compromised, raising conservation concern. These results emphasize the need for local genetic assessment of wild populations of Nile crocodiles to inform strategies for management of the species in southern Africa.

Hutchinson, J.R., Felkler, D., Houston, K., Chang, Y.-M., Brueggen, J., Kledzik, D. and Vliet, K.A. (2019). Divergent evolution of terrestrial locomotor abilities in extant Crocodylia. Scientific Reports 9: 193020.

Abstract: Extant Crocodylia are exceptional because they employ almost the full range of quadrupedal footfall patterns (“gaits”) used by mammals; including asymmetrical gaits such as galloping and bounding. Perhaps this capacity evolved in stem Crocodylomorpha, during the Triassic when taxa were smaller, terrestrial, and long-legged. However, confusion about which Crocodylia use asymmetrical gaits and why persists, impeding reconstructions of locomotor evolution. Our experimental gait analysis of locomotor kinematics across 42 individuals from 15 species of Crocodylia obtained 184 data points for a wide velocity range (0.15–4.35 ms⁻¹). Our results suggest either that asymmetrical gaits are ancestral for Crocodylia and lost in the alligator lineage, or that asymmetrical gaits evolved within Crocodylia at the base of the crocodile line. Regardless, we recorded usage of asymmetrical gaits in 7 species of Crocodyloidea (crocodiles); including novel documentation of these behaviours in 5 species (3 critically endangered). Larger Crocodylia use relatively less extreme gait kinematics consistent with steeply decreasing athletic ability with size. We found differences between asymmetrical and symmetrical gaits in Crocodylia: asymmetrical gaits involved greater size-normalized stride frequencies and smaller duty factors (relative ground contact times), consistent with increased mechanical demands. Remarkably, these gaits did not differ in maximal velocities obtained: whether in Alligatoroidea or Crocodyloidea, trotting or bounding achieved similar velocities, revealing that the alligator lineage is capable of hitherto unappreciated extreme locomotor performance despite a lack of asymmetrical gait usage. Hence asymmetrical gaits have benefits other than velocity capacity that explain their prevalence in Crocodyloidea and absence in Alligatoroidea - and their broader evolution.

Ogunro, B.N., Oguntoye, C.O., Adebisi, T.K. and David Eyarefe, O.D. (2018). Management of rectal prolapse in African Dwarf Crocodiles (*Osteolaemus tetraspis*) at the University of Ibadan Zoological Garden. Nigerian Veterinary Journal 39(4): 378–382.

Luthada-Raswiswi, R.W., Mukaratirwa, S. and O’Brien, G. (2019). Nutritional value of the Nile crocodile (*Crocodylus niloticus*) meal for aquaculture feeds in South Africa. Journal of Fisheries Sciences 13(2): 20–25.

Abstract: The Nile crocodile (*Crocodylus niloticus*) aquaculture industry, primarily for the production of skins, is amongst the largest aquaculture industry in sub-Saharan Africa and produces a range of meat waste products. The aim of this study was to evaluate the nutritional value of raw and cooked meal derived from different parts of *C. niloticus* carcasses as a potential source of protein in animal feed production, especially fish. Proximate composition of

major nutrients such as moisture, crude protein, crude fat, crude fibre, ash and selected minerals were analysed in October–November 2018 for comparison with other meal sources. Results indicated that *C. niloticus* derived meal is of a comparable quality for use in aquaculture feeds, compared to by-product meal quality reported for meal derived from bovine bones and meat, feathers, blood and other poultry by-products. Crocodile meal is hypothesised to be a suitable fishmeal replacement in the production of aquaculture feeds.

Sarker, S., Isberg, S.R., Moran, J.L., De Araujo, R., Elliott, N., Melville, L., Beddoe, T. and Helbig, K.J. (2019). Crocodilepox virus evolutionary genomics supports observed poxvirus infection dynamics on Saltwater crocodile (*Crocodylus porosus*). *Viruses* 2019: 11, 1116.

Abstract: Saltwater crocodilepox virus (SwCRV), belonging to the genus *Crocodylidpoxvirus*, are large DNA viruses posing an economic risk to Australian saltwater crocodile (*Crocodylus porosus*) farms by extending production times. Although poxvirus-like particles and sequences have been confirmed, their infection dynamics, inter-farm genetic variability and evolutionary relationships remain largely unknown. In this study, a poxvirus infection dynamics study was conducted on two *C. porosus* farms. One farm (Farm 2) showed twice the infection rate, and more concerning, an increase in the number of early- to late-stage poxvirus lesions as crocodiles approached harvest size, reflecting the extended production periods observed on this farm. To determine if there was a genetic basis for this difference, 14 complete SwCRV genomes were isolated from lesions sourced from five Australian farms. They encompassed all the conserved genes when compared to the two previously reported SwCRV genomes and fell within three major clades. Farm 2's SwCRV sequences were distributed across all three clades, highlighting the likely mode of inter-farm transmission. Twenty-four recombination events were detected, with one recombination event resulting in consistent fragmentation of the P4c gene in the majority of the Farm 2 SwCRV isolates. Further investigation into the evolution of poxvirus infection in farmed crocodiles may offer valuable insights in evolution of this viral family and afford the opportunity to obtain crucial information into natural viral selection processes in an *in vivo* setting.

Kar, S. and Pradhan, S.D. (2019). Nest and nesting of Estuarine crocodiles, *Crocodylus porosus* Schneider in Bhitarkanika National Park of Odisha, India. *The Indian Forester* (doi: 10.36808/if/2019/v145i10/149194).

Abstract: Study on nests and nesting biology of Estuarine crocodiles (*Crocodylus porosus* Schneider) was conducted for a period of ten years from April 2007 to August 2016 in Bhitarkanika National Park of Odisha, India. Crocodile nests were visited and monitored during each nesting season. The hatchling emergence and behaviour of nest guarding mother crocodiles were observed on some selected nests. The distance of crocodile nests from tidal water was recorded with a mean 6.23 ± 4.23 m. The preferred nesting materials were *Phoenix paludosa* (59.78 %), *Acrostichum aureum* (29.15%) and *Myriostachya wightiana* (5.35%). The average size of nests within a week after egg laying: height 69.80 ± 7.86 cm and diameter 152.80 ± 11.86 cm. The number of wallows varies from one to four per nest. The nest height above egg cavity was 20.75 ± 3.0 cm and below egg cavity was 25.91 ± 1.31 cm. The egg clutch size varies with size and age of nesting crocodiles. It was observed that 23 nesting mothers laid minimum 30 to maximum 67 eggs (mean = 45.7 ± 9.55). The mean egg length was 7.01 ± 0.41 cm, width 4.9 ± 0.39 cm and weight 110.6 ± 4.37 g. Nests were predated by *Varanus salvator*, *Sus scrofa* and occasionally *Python molurus*. Hatchlings were predated by *Varanus salvator* and *Haliaeetus leucogaster*.

Pfitzer, S., Boustead, K.J., Vorster, J.H., du Plessis, L. and la Grange, L.J. (2019). Adenoviral hepatitis in two Nile crocodile (*Crocodylus*

niloticus) hatchlings from South Africa. *Journal of the South African Veterinary Association* 90: 1987.

Abstract: Adenoviral infections may cause mild to severe morbidity or fatality in a large array of animal species. In crocodilians, hatchlings under 5 months of age are usually affected. However, there is a paucity of information on actual incidences in hatchlings originating from South Africa. Two cases of adenoviral hepatitis in crocodile hatchlings about 2 weeks old, bred on a commercial farm in South Africa, are described. Both hatchlings showed typical clinical signs of hepatitis. The identification of intranuclear inclusion bodies in the liver was used to differentiate between adenoviral hepatitis and chlamydial hepatitis. Although vertical transmission has never been proven in crocodiles, the young age of the affected hatchlings raises the possibility of vertical transmission. The lack of epidemiological information on adenoviral hepatitis in crocodiles highlights the need for further characterisation of the virus and targeted surveillance.

Parchizadeh, J. (2019). Large tanker lorries to reduce human-crocodile interactions in southeastern Iran. *Zoo's Print* 34(11): 26–28.

Sleboda, D.A., Stover, K.K. and Roberts, T.J. (2019). Diversity of extracellular matrix morphology in vertebrate skeletal muscle. *Journal of Morphology* (<https://doi.org/10.1002/jmor.21088>).

Abstract: Existing data suggest the extracellular matrix (ECM) of vertebrate skeletal muscle consists of several morphologically distinct layers: an endomysium, perimysium, and epimysium surrounding muscle fibers, fascicles, and whole muscles, respectively. These ECM layers are hypothesized to serve important functional roles within muscle, influencing passive mechanics, providing avenues for force transmission, and influencing dynamic shape changes during contraction. The morphology of the skeletal muscle ECM is well described in mammals and birds; however, ECM morphology in other vertebrate groups including amphibians, fish, and reptiles remains largely unexamined. It remains unclear whether a multilayered ECM is a common feature of vertebrate skeletal muscle, and whether functional roles attributed to the ECM should be considered in mechanical analyses of non-mammalian and non-avian muscle. To explore the prevalence of a multilayered ECM, we used a cell maceration and scanning electron microscopy technique to visualize the organization of ECM collagen in muscle from six vertebrates: bullfrogs (*Lithobates catesbeianus*), turkeys (*Meleagris gallopavo*), alligators (*Alligator mississippiensis*), cane toads (*Rhinella marina*), laboratory mice (*Mus musculus*), and carp (*Cyprinus carpio*). All muscles studied contained a collagen-reinforced ECM with multiple morphologically distinct layers. An endomysium surrounding muscle fibers was apparent in all samples. A perimysium surrounding groups of muscle fibers was apparent in all but carp epaxial muscle; a muscle anatomically, functionally, and phylogenetically distinct from the others studied. An epimysium was apparent in all samples taken at the muscle periphery. These findings show that a multilayered ECM is a common feature of vertebrate muscle and suggest that a functionally relevant ECM should be considered in mechanical models of vertebrate muscle generally. It remains unclear whether cross-species variations in ECM architecture are the result of phylogenetic, anatomical, or functional differences, but understanding the influence of such variation on muscle mechanics may prove a fruitful area for future research.

Stephen E. Long, S.E., Schock, T.B. and Frances, N. (2019). Examining mercury transfer in the American alligator. *Science of the Total Environment*.

Abstract: Prenatal exposure to environmental contaminants can cause developmental issues in humans and wildlife. Mercury (Hg) is particularly detrimental, often impairing the organization and

development of important organ systems by causing irreparable damage. Wildlife species that are environmentally exposed to elevated Hg are useful in modeling human exposure. A common sentinel for contaminant exposure, the American alligator, was examined for Hg transfer to the developing embryos in a series of experiments. The presence of total Hg (THg) was determined in alligator egg yolk from Yawkey Wildlife Center, SC, Lake Apopka, FL, and Lake Woodruff, FL. The mean [THg] observed were 26.3 ng/g \pm 11.0 ng/g, 8.8 ng/g \pm 5.1 ng/g, 22.6 ng/g \pm 6.3 ng/g, respectively. Maternal transfer was examined by measuring THg in nesting female blood, corresponding egg yolk, and embryo samples across three years from Yawkey Wildlife Center. We observed ~12% of the maternal [THg] in egg yolk, with 66% of the overall variation between the samples explained by correlation ($\rho=0.66$; $p<0.0001$). The correlation equation ($y=0.138x+2.5534$) was used to extrapolate maternal transfer at other locations and further evaluate alligators as developmental model for embryonic Hg exposure. The developmental compartmentalization of topically applied THg was examined using eggs collected from Lake Woodruff, a low Hg site. Through this analysis, we observed that Hg transfer is unlikely after calcification. The nest-specific [THg] that persisted through the dosing experiment further indicates that maternal transfer is occurring. To assess environmental Hg transfer, nest materials were evaluated for THg, however there was no relationship found with paired yolk THg.

Rosenblatt, A.E. and Johnson, A. (2019). An experimental test of crocodilian stick-displaying behavior. *Ecology Ethology & Evolution* (<https://doi.org/10.1080/03949370.2019.1691057>).

Abstract: Tool use has been documented across a diverse array of animals; however, this behavior has received little attention in reptiles. Recently, researchers reported observations of two crocodilian species apparently using sticks as lures to aid in the capture of nesting birds, but the evidence for the behavior was anecdotal and correlative. To explore the behavior in a more controlled situation we designed an experiment to explicitly test the ability of crocodilians to tailor stick-displaying behaviors to specific environmental contexts using four captive pond-dwelling American alligator (*Alligator mississippiensis*) populations, two of which reside near bird rookeries and two of which do not. During bird nesting season we added sticks to each pond and observed the frequency with which each population exhibited stick-displaying behaviors. We found that in most comparisons the frequency of stick-displaying behavior did not differ between rookery and no-rookery sites, while in one comparison the alligators at a no-rookery site actually displayed the behavior more frequently than a paired rookery site. Our results do not generally support the hypothesis that crocodilians tailor stick-displaying behaviors to specific environmental contexts, therefore the hypothesis that crocodilians are true tool users is also called into question. Furthermore, our results suggest that experiments on captive populations are not the ideal way to study stick-displaying behavior because of issues like unrealistic alligator densities and food provisioning.

Axelrad, D.M., Jagoe, C. and Becker, A. (2019). Everglades mercury: human health risk. Pp. 241-268 in *Mercury and the Everglades. A Synthesis and Model for Complex Ecosystem Restoration*, ed. by D. Rumbold, C. Pollman and D. Axelrad. Springer: Cham.

Abstract: Human exposure to mercury, a potent neurotoxicant, results primarily from consumption of fish contaminated with methylmercury. The Everglades is a mercury-in-fish hotspot by reason of its high deposition rate of atmospheric mercury, agricultural inputs of sulfate, and the biogeochemistry of the ecosystem. Anglers and hunters and their families who eat their catch from the Everglades are a subpopulation potentially at risk of excessive mercury exposure. Current fish consumption advisories for the Everglades recommend that anglers and hunters limit and, in some cases refrain, from consuming freshwater, marine and

estuarine fish species, as well as pig, frogs and alligators. These advisories however may not be sufficiently protective, particularly for those that consume higher than average amounts of fish and game. Here, we develop and apply a probabilistic risk assessment to examine risks to sport and subsistence hunters and anglers consuming Everglades fish and wildlife, discuss advantages of this methodology, and examine the premise that current methods and advisories are sufficiently protective.

Khadka, B.B. and Bashyal, A. (2019). Growth rate of captive Gharials *Gavialis gangeticus* (Gmelin, 1789) (Reptilia: Crocodylia: Gavialidae) in Chitwan National Park, Nepal. *Journal of Threatened Taxa* 11(15): 14998-15003.

Abstract: Gharials *Gavialis gangeticus* have been reared in *ex-situ* facilities in the Gharial Conservaton and Breeding Center (GCBC) in Chitwan Natonal Park of Nepal since the 1980s. There remains a paucity of detailed informaton concerning their growth rates, particularly with respect to season. We randomly selected 20 Gharials (45 months old) in the GCBC, tagged them, and recorded total length (TL) and weight over three warm (April-September) and two cold (October-March) seasons between 1 April 2013 and 30 September 2015. We also recorded amounts of fsh consumed by these Gharials every month over the 30-month period. On average per season, the Gharials grew by 9.48 \pm 3.63 cm (1.58 cm/month) in length and gained 2.61 \pm 1.14 kg (0.43 kg/month). Growth rates were significantly higher during warm seasons. The highest increase in both length (mean= 21.2 \pm 8.61 cm) and weight (mean= 5.59 \pm 2.12 kg) occurred during the first warm season (April 2013-September 2013) of the study, and annual growth rate was also highest during the first year. Our data indicated strong correlaton between mean length and body weight. A total of 2103.9 kg fsh was consumed by 20 Gharials over 30 months, for a mean consumpton of 3.5 kg fsh per individual per month. Mean fsh consumpton was also significantly higher during warm (96.99 \pm 37.35 kg) versus cold (29.83 \pm 17.09 kg) seasons. Survival rate was 100%. Our findings establish baseline data for growth and feeding rates of captive Gharials that will be useful in making management decisions in captve breeding and rearing facilities.

Daan, P.V.U., Pires, S.F., Sosnowski, M. and Petrossian, G. (2019). Comparing and contrasting wildlife seizures made at EU and US entry points. In *Quantitative Studies in Green and Conservation Criminology: The Measurement of Environmental Harm*. Routledge: New York.

Kohno, S., Zhu, J. and Guillette, L.J. Jr. (2019). Stress responses in the chemistry and mRNA abundance of the peripheral blood in the American alligator. *J. Exp. Zool. A Ecol. Integr. Physiol.* (doi: 10.1002/jez.2337).

Abstract: To monitor physiological and toxicological conditions in an endangered species, noninvasive to minimally invasive sampling methods are needed. We analyzed peripheral blood cells to determine if we could monitor some physiological responses of the American alligator following capture stress. Juvenile American alligators were restrained for 16h to examine the stress response in plasma and blood cells. Plasma corticosterone concentrations were increased by restraint as were plasma concentrations of aspartate aminotransferase (AST), creatine kinase (CK), uric acid, and glucose; a sexually dimorphic response was seen in AST and CK concentrations. The lapse time of restraint was associated with altered messenger RNA (mRNA) levels of the glucocorticoid receptor (GCR) in red blood cells and JUN proto-oncogene in both white and red blood cells. A two-way cluster analysis revealed that two major clusters of factors were associated with the responses seen: (a) mRNA levels of GCR and heat-shock proteins in both blood cells were associated with plasma corticosterone concentration, whereas (b) androgen receptors and JUN mRNA levels in both blood cells were associated with

cloacal temperature and body composition. Blood cells appear to be an excellent source to examine the cellular stress response to steroid hormone signals in mRNA levels. We propose that this approach, using blood cells, could provide essential insights into the molecular responses associated with stress in reptiles as well as many other nontraditional model species, including endangered species.

Kondrashova, T., Blanchard, J., Knoche, L., Potter, J. and Young, B.A. (2019). Intracranial pressure in the American alligator (*Alligator mississippiensis*): Reptilian meninges and orthostatic gradients. *J. Comp. Physiol. A Neuroethol. Sens. Neural Behav. Physiol.* (doi: 10.1007/s00359-019-01386-6).

Abstract: The cranial meninges of reptiles differ from the more widely studied mammalian pattern in that the intraventricular and subarachnoid spaces are, at least partially, isolated. This study was undertaken to investigate the bulk flow of cerebrospinal fluid, and the resulting changes in intracranial pressure, in a common reptilian species. Intracranial pressure was measured using ocular ultrasonography and by surgically implanting pressure cannulae into the cranial subarachnoid space. The system was then challenged by: rotating the animal to create orthostatic gradients, perturbation of the vascular system, administration of epinephrine, and cephalic cutaneous heating. Pressure changes determined from the implanted catheters and through quantification of the optic nerve sheath were highly correlated and showed a significant linear relationship with orthostatic gradients. The catheter pressure responses were phasic, with an initial rapid response followed by a much slower response; each phase accounted for roughly half of the total pressure change. No significant relationship was found between intracranial pressure and either heart rate or blood flow. The focal application of heat and the administration of epinephrine both increased intracranial pressure, the latter influence being particularly pronounced.

Beucher, M. and Prôa, M. (2019). La restauration du crocodile historique du Muséum des Sciences naturelles d'Angers. Conservation, exposition, Restauration d'Objets d'Art (<http://journals.openedition.org/ceroart/6921>).

Ziegler, T., Tao, N.T., Minh, N.T., Manalo, R., Diesmos, A. and Manolis, C. (2019). A giant crocodile skull from Can Th, named "Dau Sau", represents the largest known saltwater crocodile (*Crocodylus porosus*) ever reported from Vietnam. *Vietnam Academy of Science and Technology Journal of Biology* 41(4) (<https://doi.org/10.15625/0866-7160/v41n4.14581>).

Abstract: We report on a large crocodile skull recovered from a river bank in August 2010 near Dau Sau Bridge, in An Binh, Ninh Kieu District, Can Tho Province, in southern Vietnam. As the skull from Can Tho, named "Dau Sau" herein, is now deposited in the Vietnam National Museum of Nature, Hanoi, we reinvestigated the circumstances surrounding its discovery and provide exact measurements. Skull length (dorsal mid-point) is 70.7 cm. The morphological features confirm it is from a Saltwater crocodile (*Crocodylus porosus*), and not a Siamese crocodile (*C. siamensis*), which historically also occurred throughout the Mekong Delta of Vietnam. Skull measurements are compared with those of other large *C. porosus* skulls for which reliable estimates of total length are available. We also provide measurements of the prepared skull of "Lolong" (69.8 cm), a 6.17 m long *C. porosus* captured in the Philippines in 2011. On the basis of known skull length:total length ratios the crocodile from Can Tho is estimated to be 6.3-6.8 m long. The skull of Dau Sau is likely to have been buried for at least 100 years. We discuss the origin of the local name Dau Sau, which has traditional and cultural significance, and provide historical reports of crocodiles in the area. Dau Sau is smaller than the largest known *C. porosus* skull (76 cm), but is the largest ever reported from Vietnam, and one of the largest *C. porosus* known.

Venegas-Anaya, M., Del Rosario R., S., Venegas, M.A., Aguilar M., M., Alonso J. J., Y., Rivera, B.I., Escobedo-Galván, A.H. (2019). Geomatics in conservation: Habitat status and population ecology of crocodiles and alligators of the Gulf of Montijo Wetland, Panama. *In* 7th International Engineering, Sciences and Technology Conference, 9-11 October 2019. IEEE: Panama.

Abstract: To evaluate the impacts of the expansion of human development on American crocodile and spectacled caiman in the Wetlands of the Gulf of Montijo, Veragua Province, Panama, we conducted a geomatics assessment of the main watersheds that drain into the Gulf of Montijo, in the Eastern Tropical Pacific of Panama. We also performed a rapid inventory of the two species that inhabit the area. To evaluate habitat changes we used ArcMap 10.6 and 1992, 2000 and 2012 Land Covers developed by the Environment Ministry of Panama. To calculate the potential habitat area of the American crocodile and the spectacled caiman, we used the area limited by a 400-m-high contour line and the coastline of the Gulf of Montijo. Crocodile and caiman populations assessment was done in dry season (January to March) of 2018. In 23 nights we covered 74.43 km, counted 215 animals, and captured and released 36 individuals. Sex ratio for both species was 2:6 females/males. The encounter rate for American crocodile was 0.21 ind/km (n= 16; distance covered = 74.43 km; visited sites= 12) and for spectacled caiman was 0.27 ind/km (n= 20; distance covered= 74.43 km; visited sites= 12). Suitability of habitat area for crocodiles and caimans increased on 3.8% between 1992 and 2012 due to the switch between forest area and agriculture areas. The considerable increase in non-native forest plantations and invasive species has been shown, in the field, to be a relevant cause of the fragmentation of these habitats.

King, C.M. (2019). Introduction (82 million years ago to AD 1280). *In* Invasive Predators in New Zealand. Palgrave Studies in World Environmental History. Palgrave Macmillan: Cham.

Abstract: New Zealand is the only emergent part of Zealandia, an isolated fragment of Gondwanaland, on which a historic series of three endemic faunas can be distinguished: (1) From 82 to 55 mya, a subset of Gondwana species survived, including at least six species of dinosaurs, at least one crocodile and proto-mammals. (2) From 55 to 25 mya, a distinctly new endemic fauna was formed from new arrivals integrated with ancient survivors, as Zealandia rafted eastwards and gradually sank into an archipelago of low-lying islands. (3) From 25 mya to the end of the Pleistocene, earth movements and volcanic activity created the mountainous geography of modern New Zealand. Key fossil sites of the Miocene age (16 mya) preserve samples of tropical forest and fauna now long vanished. New alpine habitats <5 million years old are populated with endemic species evolved from forest ancestors as the land uplifted beneath them. In the absence of any terrestrial mammals or snakes, flightlessness and large size evolved several times independently, associated with slow breeding and low mortality. The history of New Zealand explains why the endemic fauna were so uniquely vulnerable to the arrival of human and mammalian predators.

Kido Cruz, M.T., Zuñiga Marroquín, T. and Kido Cruz, A. (2019). Uses, assessments and perceptions of wildlife: Case study in Loma Bonita, Oaxaca. *Revista de Geografía Agrícola* 63(10) (dx.doi.org/10.5154/r.aga.2019.63.07).

Abstract: Even though there is a valid discourse on environmental protection in our country, few efforts have been made in this area, especially when it comes to wildlife. Part of the reason is due to the lack of information and studies on the subject. The objective of this paper is to contribute to our knowledge about the perception of three groups of wild fauna, namely birds, mammals and reptiles in the lower region of the Papaloapan Basin, held by three different groups of the local population: producers, students and university professors. To do this, we used different data analysis techniques: canonical correlation, use indicators and the cost-benefit method.

The results yielded 88 identified species, of which 10 lived in the region in the past but are currently reported as non-existent. The most prominent uses are as food and as pets. Among the species with the highest economic value, the crocodile and parrots stand out.

Du, J., Wang, W., Chan, J.F., Wang, G., Huang, Y., Yi, Y., Zhu, Z., Peng, R., Hu, X., Wu, Y., Zeng, J., Zheng, J., Cui, X., Niu, L., Zhao, W., Lu, G., Yuen, K.Y. and Yin, F. (2019). Identification of a novel ichthyic parvovirus in marine species in Hainan Island, China. *Frontiers in Microbiology* (doi: 10.3389/fmicb.2019.02815).

Abstract: Parvoviruses are a diverse group of viruses that are capable of infecting a wide range of animals. In this study, we report the discovery of a novel parvovirus, tilapia parvovirus HMU-HKU, in the fecal samples of crocodiles and intestines of tilapia in Hainan Province, China. The novel parvovirus was firstly identified from crocodiles fed with tilapia using next-generation sequencing (NGS). Screening studies revealed that the prevalence of the novel parvovirus in crocodile feces samples fed on tilapia (75-86%) was apparently higher than that in crocodiles fed with chicken (4%). Further studies revealed that the prevalence of the novel parvovirus in tilapia feces samples collected at four areas in Hainan Province was between 40 and 90%. Four strains of the novel parvovirus were identified in this study based on sequence analyses of NS1 and all the four strains were found in tilapia in contrast only two of them were detected in crocodile feces. The nearly full-length genome

sequence of the tilapia parvovirus HMU-HKU-1 was determined and showed less than 45.50 and 40.38% amino acid identity with other members of Parvoviridae in NS1 and VP1 genes, respectively. Phylogenetic analysis based on the complete helicase domain amino acid sequences showed that the tilapia parvovirus HMU-HKU-1 formed a relatively independent branch in the newly proposed genus *Chaphamaparvovirus* in the subfamily Hamaparvovirinae according to the ICTV's most recent taxonomic criteria for Parvoviridae classification. Tilapia parvovirus HMU-HKU-1 likely represented a new species within the new genus *Chaphamaparvovirus*. The identification of tilapia parvovirus HMU-HKU provides further insight into the viral and genetic diversity of parvoviruses and its infections in tilapia populations need to be evaluated in terms of pathogenicity and production losses in tilapia farming.

Earl, L. (2019). *Crocodile Fever: A True Story of Adventure*. Red Kestrel Books. [First published in 1954, this is a fascinating look at the life and adventures of Bryan Herbert Dempster. Born in South Africa, he was perhaps the first white man to successfully hunt crocodiles, not for sport but to obtain their skins for his livelihood. The book details the risks and special techniques he developed by long trial-and-error to hunt these river creatures, as well as his personal struggles with his failing health, his estranged family, and impassive government officials. Much of the hunting took place in the Kariba Gorge of the Zambezi River, now completely inundated by the Kariba Dam and part of the world's largest man-made lake].

Steering Committee of the Crocodile Specialist Group

Chair: Professor Grahame Webb, P.O. Box 530, Karama, NT 0813, Australia

For further information on the CSG and its programs on crocodile conservation, biology, management, farming, ranching, or trade, contact the Executive Office (csg@wmi.com.au) or Regional Chairs

Deputy Chairs: Alejandro Larriera (alelarriera@hotmail.com); Dr. Perran Ross (pross@ufl.edu); Charlie Manolis (cmanolis@wmi.com.au); Christine Lippai (lippainomad@gmail.com).

Executive Officer: Tom Dacey, P.O. Box 530, Karama, NT 0813, Australia (Tel.: +61.419704073; csg@wmi.com.au).

Regional Chair, East and Southern Africa: Christine Lippai (lippainomad@gmail.com). **Regional Vice Chairs:** Dr. Alison Leslie (aleslie@sun.ac.za); Howard Kelly (crocfarm@venturenet.co.za); Dr. Xander Combrink (CombrinkAS@tut.ac.za).

Regional Chair, West and Central Africa: Dr. Matthew Shirley (mshirley@rerespecies.org). **Regional Vice Chairs:** Prof. Guy Apollinaire Mensah (mensahga@gmail.com); Christine Lippai (lippainomad@gmail.com); Dr. Nathalie Kpera (nathaliekpera@gmail.com).

Regional Chair, East and Southeast Asia: Lonnie McCaskill (lonnie.mccaskillcroc@gmail.com). **Regional Vice Chairs:** Prof. Wu Xiaobing (wuxb@ahnu.edu.cn); Dr. Choo Hoo Giam (giamc@singnet.com.sg); Dr. Nao Thuok (thouk.nao.uss@gmail.com); Kornvika Youngprapakorn (panyafarm@gmail.com); Yosapong Tamsiripong (yosapong@srirachamoda.com); Ranier Manalo (rimanaloecology@yahoo.com); Dr. Luke Evans (lukeevans603@yahoo.co.uk); Oswald Braken Tisen (oswaldtisen@sarawakforestry.com); Adrian Sugiarto (suryaraycroc@gmail.com); Dr. Steve Platt (sgplatt@gmail.com).

Regional Chair, Australia and Oceania: Charlie Manolis (cmanolis@wmi.com.au). **Regional Vice Chairs:** Eric Langelet (elangelet@mainland.com.pg); Dr. Matthew Brien (croc matt@hotmail.com).

Regional Chair, South Asia and Iran: Anslem de Silva (kalds@sltnet.lk). **Regional Vice Chairs:** Madhava Botejue (madhavabotejue@gmail.com); Maheshwar Dhakal (maheshwar.dhakal@gmail.com); Raju Vyas (razoovyas@gmail.com); Abdul Aleem Choudhury (aleemc1@gmail.com); Asghar Mobaraki (amobaraki@yahoo.com); Dr. S.M.A. Rashid (carinam.bangladesh@gmail.com).

Regional Chair, Latin America and the Caribbean: Dr. Pablo Siroski (cocokaima@hotmail.com). **Regional Vice Chairs:** Alfonso Llobet (alfyacare@yahoo.com); Dr. Hesiquio Benítez Diaz (hbenitez@conabio.gob.mx); Dr. Marisa Tellez (marisatellez13@gmail.com); Dr. Luis Bassetti (luisbassetti@terra.com.br); Dr. Sergio Balaguera-Reina (sergio.balaguera-reina@ttu.edu); Manuel Tabet (alonsotabet@nauta.cu); Dr. Laura Porras Murillo (lauporras@gmail.com); Regional Trade: Alvaro Velasco (velascocaiman@gmail.com).

Regional Chair, Europe: Thomas Ziegler (ziegler@koelnerzoo.de); **Regional Vice Chair:** Fabian Schmidt (fabian.schmidt@zoobasel.ch).

Regional Chairs, North America: Dr. Ruth Elsey (relsey@wlf.la.gov); Allan Woodward (allan.woodward@myfwc.com). **Regional Vice Chairs:** Jeb Linscombe (jlinscombe@wlf.la.gov); Dr. Frank Mazzotti (fjma@ufl.edu); Dr. Thomas Rainwater (trainwater@gmail.com).

Vice Chair, Industry: TBC. **Deputy Vice Chairs:** Pamela Ashley (Jdalligator@aol.com); Yoichi Takehara (official@horimicals.com); C.H. Koh (ch.koh@henglong.com); Kevin Van Jaarsveldt (kvj@mweb.co.za); Enrico Chiesa (enricochiesa@italhide.it); Christy Plott (christyplott@amtan.com); Jerome Caraguel (jerome.caraguel@hcp-rtl.com); Simone Comparini (renzocomparini@libero.it); Manuel Muñiz (moreletii@gmail.com); Helen Crowley (helen.crowley@kering.com).

Vice Chair, Trade Monitoring: John Caldwell (john.caldwellxx@mail.com).

Vice Chairs, Veterinary Science: Dr. Paolo Martelli (paolo.martelli@oceanpark.com.hk); Dr. Cathy Shilton (Cathy.Shilton@nt.gov.au).

Vice Chair, Zoos: Dr. Kent Vliet (kvliet@ufl.edu).

Vice Chair, Taxonomy: Dr. Kent Vliet (kvliet@ufl.edu). **Deputy Vice Chair:** Dr. Chris Brochu.

Vice Chair, Community Participation and Public Education: Myrna Cauilan-Cureg (myrna-cauilan_cureg@yahoo.com.ph).

Vice Chairs, General Research: Dr. Valentine Lance (valcrocdoc@gmail.com); Dr. Mark Merchant (mmerchant@mcneese.edu); Dr. Carlos Piña (cidcarlos@infoaire.com.ar).

Vice Chair, Legal Affairs: Curt Harbsmeier (charbsmeier@hidalaw.com).

CSG IUCN Red List Authority: Dr. Perran Ross (pross@ufl.edu); Dr. Sally Isberg (sally@crocresearch.com.au).

Honorary Steering Committee Members: Ted Joanen (USA), Romulus Whitaker (India), Phil Wilkinson (USA), Prof. F. Wayne King (USA), Dietrich Jelden (Germany).

Task Force/Working Group Chairs: Future Leaders Program, Dr. Sergio Balaguera-Reina (sergio.balaguera-reina@ttu.edu); Tomistoma Task Force, Bruce Shwedick (Bshwedick@aol.com).