CROCODILE SPECIALIST GROUP NEWSLETTER

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IUCN • Species Survival Commission

CROCODILE

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GROUP

NEWSLETTER

VOLUME 42 Number 4
OCTOBER 2023 - DECEMBER 2023

IUCN Species Survival Commission

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Cover: Wild *Tomistoma schlegelii* basking on the Arut River, Kalimantan, Indonesia. Photograph: Pak Suryadi, Biodiversity Division, United Plantations-PTSSS, Kalimantan, Indonesia.

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:
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James Hennessy, The National Reptile Zoo, Ireland.
Cathy Shilton, Darwin, Australia.

Editorial

We wish all CSG members and families a happy and properous new year. Hope that 2024 is a good year for all.

We extend our most heart-felt congratulations to Professor Grahame Webb, ex-Chair of the CSG, who was appointed as a Member of the Order of Australia in late January 2024. The Member of the Order of Australia is awarded for service in a particular locality or field of activity or to a particular group. In the Australian honours system, appointments to the Order of Australia confer the highest recognition for outstanding achievement and service. Grahame is without doubt a worthy recipient of this honour.

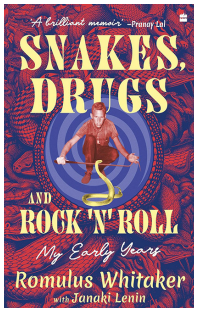
Within the Latin American region, three crocodilian-related events were held under the auspices of the "XV International Congress on Management of Wildlife of Amazonia and Latin America" (CIMFAUNA), held in Colombia in November 2023. These were the: Sustainable Use of Reptiles Symposium; Current Paradigms in the Conservation and Use of Crocodilians in Latin America Symposium; and, Workshop on Technical Principles for the Study, Management, and Conservation of Caimans and Crocodiles in Latin America. Summaries of each event are on pages 5-8.

The "3rd Forum of Crocodiles in the Philippines" was held on 8-11 November 2024. We hope to include a detailed summary of this meeting in the next Newsletter.

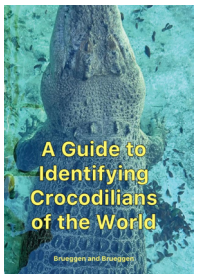
The CITES Standing Committee finally approved the Mexican plan for the Vaquita that was provisionally accepted last April. So, for crocodilians there is no risk of a new ban on CITES-listed species in the near future. However, the situation will continue to be monitored by CITES.

The 27th CSG Working Meeting will take place in 11 weeks (15-20 April 2024), and we urge people considering participation in this important biennial event to register as soon as possible. Early Bird registration has been extended to 15 February 2024. We also urge participants to lodge submissions/abstracts for oral and/or poster presentations as soon as possible. Working Meetings are an opportunity to showcase the diversity of work being undertaken around the world on crocodilians. See page 4 for more details on the Working Meeting and associated events (drone and veterinary workshops, Steering Committee meeting, field trip, etc.).

Winter CrocFest 2023 took place on 9 December 2023, at Wild Florida in Kenansville, Florida. Over $US40,000 was raised for research and conservation efforts for American crocodiles (*Crocodylus acutus*) in southern Guatemala conducted by Valerie Corado-Garcia and Venetia Briggs-Gonzalez. Currently, research on *C. acutus* is being conducted in many range states, and CrocFest has previously funded a small part of that work. However, the Pacific slope of Guatemala has not yet been a focal study site for any of the crocodilians that inhabit that country. The goal of this project is to establish baseline knowledge for the wild *C. acutus* populations on the southern coast and to assess anthropogenic impacts on the species. Project objectives include: determining population structure of *C. acutus*; identifying habitat classification and association between vegetation structure and relative abundance of *C. acutus*; identifying anthropogenic threats to wild *C. acutus* populations; and, assessing local knowledge, perception and traditional use practices for *C. acutus* in communities on the southern coast of Guatemala.



Most CSG members will be familiar with the long-term involvement of Rom Whitaker with crocodilians and snakes. Harper Collins Publishers India has announced the forthcoming publication of Rom's memoirs, entitled "Snakes, Drugs and Rock 'n' Roll", authored by Rom and Janaki Lenin. The ebook should be available by the end of January 2024.



Another publication, "A Guide to Identifying Crocodilians of the World" by long-time CSG members Jen Brueggen and John Brueggen, is also available now. It is an easy to understand guide identifying crocodilians from around the world. The book is designed to feature the characteristics that make each species of crocodilian unique.

Alejandro Larriera and Charlie Manolis, *CSG Co-Chairs*.

CSG Student Research Assistance Scheme

The Student Research Assistance Scheme (SRAS) and Fritz Huchzermeyer Veterinary Science Student Research Assistance Scheme (FHVS-SRAS) provided funding to four students in the October-December 2023 quarter (see below). This brings the total number of grants awarded in 2023 to 15.

1. Emma Jarlbaek (Sweden): Habitat feasibility and public perception on the *ex-situ* conservation and reintroduction of *C. mindorensis*.

2. Miriam Boucher (USA): Exploring regional trends in alligator diet and ecotoxicology.

3. Barthira Rezende de Oliveira (Brazil): Reproductive ecology of the Black caiman (*Melanosuchus niger*) in Araguaia National Park, Tocantins, northern Brazil: An initial approach.

4. James Watson (USA): Monitoring of *Tomistoma schlegelii* in southwestern Sarawak using eDNA and traditional telemetry methods.

Dr. Sally Isberg, *CSG Executive Officer (csg@wmi.com.au)*.

27th CSG Working Meeting

Theme: Crocodile Conservation: What Works!

The Centre for Crocodile Research (www.crocresearch.com.au) is proud to host the 27th CSG Working Meeting in Darwin, Northern Territory, Australia, in April 2024. We cordially invite all people interested in crocodilians to attend this biennial event. The draft program is:

Day/Date	Program	Social Event
Sun, 14 April	Drone workshop, Veterinary workshop	
Mon, 15 April	Steering Committee meeting (and/or Morning Field Trip)	Welcome drinks
Tue, 16 April	Official welcome/working meeting	Cocktail poster session
Wed, 17 April	Working meeting (and/or Morning Field Trip)	Gala dinner and auction
Thu, 18 April	Working meeting (and/or Morning Field Trip)	
Fri, 19 April	Working meeting	Banquet night
Sat, 20 April	Post-meeting Field Trip (Adelaide and Mary Rivers)	

Workshops: Drone and Veterinary Workshops being held on 14 April at Crocodylus Park are each limited to **50** participants - so register now to ensure your spot. The Drone Workshop will include demonstrations and discussion of current uses and advancements in drone technology and its application to crocodilian management and conservation. Lead co-ordinator: Dr. Matt Brien. The Veterinary Workshop will include presentations on topics such as surgical procedures, skin histology/quality, as well as a practical session on necropsy. Lead co-ordinator: Dr. Cathy Shilton.

Abstracts: Call for Abstracts for oral presentations and poster presentations is still open. See www.csg2024.com for author insruction and online portal for abstract submission.

Morning Field Trips: Come along on this rare opportunity to accompany the Northern Territory Crocodile Management Team as they conduct their routine patrols of Darwin Harbour as part of the program to keep the public safe. These field trips can be booked for Monday, Wednesday or Thursday mornings. You will be back at the conference venue by midday to participate in the working meeting schedule. Limited to **12** people per day and places are filling fast.

Field Trip: The post-meeting field trip on 20 April promises to be awesome, but is limited to **98** participants - be quick to register your spot! Participants will partake in cruises on two of the most densely Saltwater crocodile populated rivers in the Top End of Australia - the Adelaide River (Jumping Crocodile Cruise) and Corroborree Billabong (Mary River).

Meeting Website: Details on accommodation, venue, registration, etc., are available at: www.csg2024.com or follow us on Facebook (Crocodile Specialist Group Working Meeting 2024)!

See you in Darwin in April 2024!

Dr. Sally Isberg, Chair of Organising Committee (sally@crocresearch.com.au)

Wildlife Conservation Drone and Technology Summit

At the recent "Wildlife Conservation Drone and Technology Summit" (wcdws.com) held in Burnet, Texas, USA, on 6-9 October 2023, there was a workshop devoted specifically to drones and new technology being used and developed for crocodilian field conservation. There were a number of CSG members in attendance, giving in-person and virtual presentations, posters and panel discussion.

Figure 1. Lonnie McCaskill (left) and Carlos Piña (right) participating in workshop.

The Technology in Crocodile Conservation Workshop provided an important venue for crocodilian researchers to share their research, discuss successes and failures in using drones and other technologies, and opportunities for future collaboration and research on this important, but difficult to monitor in the wild, group of reptiles. With technology advancing rapidly, it was a great opportunity to discuss some of the projects and best practices being used in the field on a global scale in crocodilian field conservation.

Abstracts of presentations, posters and round table, can be viewed at "https://www.wcdws.com".

Lonnie McCaskill *(lmccaskill4wildlife@gmail.com)* and Carlos Piña *(pina.carlos@uader.edu.ar)*, Co-Chairs of CSG Drone Working Group.

XV International Congress on Management of Wildlife of Amazonia and Latin America

The following events were held under the auspices of the "XV International Congress on Management of Wildlife of Amazonia and Latin America" (CIMFAUNA; https://comfauna.org/xvcimfauna-congreso-2023) in Santa Marta, Colombia, in November 2023.

1. Symposium: Current Paradigms in the Conservation and Use of Crocodilians in Latin America

The Community of Management of Wildlife in the Amazon and Latin America (Comunidad de Manejo de Fauna Silvestre en América Latina - COMFAUNA), an organization promoting sustainable use and conservation of wildlife, habitats, and local governance of human societies dependent on nature in these regions, committed to an event fostering the exchange of knowledge, with the symposium embodying the principles of XV CIMFAUNA.

Crocodilians, key to global conservation efforts, are most diverse in Latin America and face numerous conservation challenges. Historically vital for local communities as a food source and economic asset, these species have also been central in habitat and species conservation models. Over time, conservation strategies have evolved, often involving communities in sustainable use systems to preserve species and improve livelihoods. These strategies have adapted to changing market dynamics, economic crises, and shifting perceptions among stakeholders, including governments and social groups. These evolving experiences provide critical lessons for the definition of the current Paradigms in the Conservation and Use of Crocodilians. Recognizing the need to revisit and realign past practices with current conservation paradigms, there's a priority in Latin America to adapt these practices for the sustainable coexistence of crocodilians and human societies, balancing ecological and socio-economic needs.

The symposium aimed to introduce various approaches pertinent to the current conservation and use context, focusing on both *ex-situ* and *in-situ* management of crocodilians in Latin America. It showcased a range of conservation efforts from multiple countries in the region and served as a platform for sharing and discussing essential criteria and guidelines for evaluating different conservation strategies. Topics covered included sustainable management, captive breeding, and other actions designed to adapt to current challenges, such as the environmental crisis, shifts in trade trends for products and by-products, and novel approaches for the use and conservation of crocodilians.

The symposium's program featured 28 oral presentations and attracted a full room of 80 attendees, marking it as a highlight event in the activities of CIMFAUNA. The symposium emphasized conservation strategies implemented for the Black caiman in Guyana and Brazil, the American crocodile in Colombia and Mexico, and the Orinoco crocodile in Colombia and Venezuela. It is important to acknowledge the contributions of the following institutions: the Tropical Conservation and Development Program at the University of Florida, The Dallas World Aquarium, the Consejo Profesional de Biología de Colombia, Fundación ORNIAT, the Corporación Autónoma Regional del Atlántico, and, Crocfest.

As an outcome of the Symposium, the goal was to establish a network of contacts among professionals, students, and other interested parties, focusing on the most significant topics identified during the discussions. Additionally, we

aim to draft a document summarizing the main insights from this symposium and to promote future similar events. These efforts are intended to provide opportunities for the new generation of crocodilian conservationists to contribute to defining the new paradigms for the conservation of this important taxonomic group.

Robinson Botero-Arias *(Tropical Conservation Development Program, University of Florida, Gainesville, FL, USA and Wildlife Ecology and Conservation Department, University of Florida, Gainesville, FL, USA; robincrocs@gmail.com)* and Pablo Siroski *(Laboratorio de Ecología Molecular Aplicada (ICiVET - UNL), CONICET, Esperanza, Santa Fe, Argentina and Ministerio de Medio Ambiente y Cambio Climático, Santa Fe, Argentina; cocokaima@gmail.com)*.

2. Symposium: Sustainable Use of Reptiles

The Symposium "Sustainable Use of Reptiles" was celebrated on 23 November 2023. Attendees and invited speakers, whose work related to conservation and use of reptiles and links with local communities, participated in the Congress.

At the end of the presentations, there was discussion and exchange among the participants, highlighting key points and current challenges. The taxonomic groups discussed were turtles, lizards, crocodilians and anacondas. Several CSG members organized and participated in the Symposium (Alejandro Larriera, Melina Simoncini, Carlos Piña, Sofía Pierini, Pamela Leiva and Alba Imhof).

Discussions concluded that the sustainable use of the four groups has the same problems and challenges: lack of environmental education and communication; need to unify discourses in pursuit of the usefulness of use programs (not only environmental aspects, but also economic and social); acceptance of the use of meat, but not leather (considered luxury); organizational costs are high compared to the low value of byproducts; market demands affect the continuity of the programs; and, the need to prioritize local people as the main beneficiaries of sustainable use programs. In conclusion, interdisciplinary work is required to deal with crises, turning them into opportunities and lessons.

Melina Simoncini, *COMFAUNA (president), Proyecto Yacaré and researcher at CICYTTP/CONICET, Santa Fe, Argentina (melinasimoncini22@yahoo.com.ar)*.

3. Workshop: Technical Principles for the Study, Management, and Conservation of Caimans and Crocodiles in Latin America

The workshop took place on 18-19 November 2023, at two important Crocodilian Farms in Colombia - Repticosta S.A.S (Puerto Giraldo, Atlántico) and Exotika Leather S.A.S. (Repelón, Atlántico). It facilitated an important experience for bringing insights into crocodilian conservation to a diverse audience, including early-career researchers, students, community leaders, and environmental government agencies in the Colombian context, but with the important participation of researchers from other American countries such as Argentina, Cuba, Mexico, USA and Venezuela.

The workshop also aimed to address the needs of those actively involved in crocodilian studies for management strategies and conservation actions. The overarching objectives were to strengthen the understanding of basic concepts in crocodilian study, promote unified data collection and interpretation criteria across diverse contexts, and promote a network of regional contacts for collaborative conservation strategies.

Discussions during the workshop centered around the biological, social, and cultural aspects of crocodilian study and management, focusing on building robust conservation actions. Participants actively shared their findings and conclusions from various conservation strategies, facilitating valuable cross-cultural learning experiences. Presentations delved into diverse *in-situ* and *ex-situ* management approaches for crocodilian populations in Latin America, emphasizing the integration of quantitative data for effective population assessment.

The comprehensive range of topics covered included the biology and ecology of crocodilians, identification and distribution of Latin American crocodilians, global conservation strategies, the use of genetic tools to inform conservation and management actions, human-crocodile conflict evaluation, monitoring criteria for wild crocodilian populations, field methodologies for studying crocodilian biology and ecology, and technological advancements in crocodilian ecological research, mainly the use of UAVs (drones) as potential support in the fieldwork data collection.

The workshop's impact was significant, as participants gained a solid foundation in crocodilian conservation practices, ensuring they were equipped with the knowledge needed for effective conservation efforts. The adoption of unified data collection and interpretation criteria enhanced regional conservation efforts, ensuring a cohesive approach to crocodilian management. A new generation of conservationists has access to specialist expertise, fostering motivation and commitment to future action.

During this workshop, participants had the opportunity to share the findings and conclusions of several conservation strategies, as well as participate in the exchange of ideas with other participants, especially new conservationists from different countries in Latin America. It sought to present different strategies for the *ex-situ* and *in-situ* management of crocodilian populations in Latin America. It also focused on integrating quantitative information into conservation and management to understand the ecological status of crocodilian species.

For the new generation, access to the expertise of specialists, as well as training on the principles for the study, management, and conservation of crocodilians, represents not only an excellent opportunity to build a solid foundation of knowledge on the subject and create networks of collaboration but also a powerful source of motivation that promotes the continuity and improvement of conservation efforts. Ultimately, this type of platform demonstrates that passion can not only lead to knowledge, but also to a lifestyle, professional development opportunities, and valuable friendships.

The workshop was a key event, substantially strengthening the regional capacity for effective crocodilian conservation in Latin America. The exchange of knowledge, collaborative network building, and focus on actionable strategies have paved the way for a more secure future for these vital species. The workshop's impact reverberates through the newly empowered conservationists and the enhanced collective efforts towards the preservation of caimans and crocodiles in the region.

The workshop had 30 participants, and with the logistical and economic support of several institutions, the fees for the participants were covered. It is important to acknowledge the following institutions: Tropical Conservation Development Program, University of Florida; The Dallas World Aquarium; Consejo Profesional de Biologia de Colombia; Fundación ORNIAT; Corporación Autónoma Regional del Atlántico; Crocodilos de Colombia S.A., Repticosta S.A.S.; Exotika Leather S.A.S.; and, Vivarium del Caribe.

The talks and activities were planned and led by Robinson Botero-Arias (TCD, UF), John Calderón (Cocodrilos de Colombia), Camila Duran (Wildlife Conservation Society - Colombia), John Jairo Gómez (Fundación ORNIAT), Omar Hernandez (FUDECI), Lonnie McCaskill, Pablo Siroski (ICiVET - UNL), Mario Vargas-Ramírez (Estación de Biología Tropical Roberto Franco) and Álvaro Velasco (FUDECI).

The expectation after this successful event is a replication of similar activity in the next XVI CIMFAUNA, planned to happen in 2025 in San Cristobal de las Casas, Mexico.

Testimonials and comments

Sentaron muy acertadamente las bases sobre el estudio, manejo y conservación de los caimanes y cocodrilos, me fui satisfecha porque aprendí un montón y con muchas ganas de aprender más y poder contribuir con la conservación de nuestras poblaciones. Muchas gracias - Jessica León (Colombia)

Muy buena experiencia, el conocimiento compartido fue de muy buena calidad. Creo que estos espacios hacen que el trabajo sea más fácil para todos" - Luis (Cuba)

El Curso técnico precongreso principios técnicos para el estudio, el manejo y la conservación de caimanes y cocodrilos en Latinoamérica tuvo una afluencia de importante de personas alrededor de 30 participantes que considero muestra un buen número de personas que está interesada en la conservación de estos animales. El curso llenó las expectativas que teníamos desde un principio de conocer la materia prima que existe a nivel de Colombia para la conservación de los cocodrilos y se abordaron temáticas de importancia para el estudio y la conservación de estas especies. Por ser el primer ejercicio, es importante considerar que se pueden realizar más cursos con diferentes niveles de profundidad que podrían ser más prácticos como por ejemplo en la ejecución de técnicas de captura técnica de toma de muestra genética análisis de los datos, estadística de datos. Que ayuden a unificar un criterio y metodología en el registro datos, el análisis de resultados a nivel nacional y comparar la información que tenemos en Colombia" - John Gómez (Colombia)

Poder participar en el precongreso fue una tremenda oportunidad de poder intercambiar con excelentes colegas. Desde el punto de vista técnico fueron bien interesantes los debates y las inquietudes de los nuevos especialistas que se incorporan. Una tremenda oportunidad de ver cuándo se hace por la conservación de las especies en otras latitudes. De forma general aprendí, me divertí muchísimo, muchas gracias por la oportunidad - Gustavo Sosa (Cuba)

El curso Principios técnicos para el estudio, el manejo y la conservación de caimanes y cocodrilos en América Latina fue una excelente oportunidad de intercambiar conocimientos con investigadores reconocidos en el área que querían compartir sus conocimientos con investigadores apenas iniciándose en este mundo de los cocodrilos. Fue una excelente plataforma para hacer contactos valiosos y proponer colaboraciones futuras - Camila Duran (Colombia)

Disfruté mucho de un curso en pro de la conservación de cocodrilos, en el que pude adquirir conocimientos que me hicieron darme cuenta de que hay aspectos relacionados con los cocodrilos que no son tan complicados y ofrecen numerosas oportunidades para trabajar con estos fascinantes reptiles. Este curso me permitió acercarme más a sus diversas metodologías y entender la importancia de su conservación en el ecosistema. Lo más destacado de la experiencia fue la calidad de los profesionales involucrados, quienes demostraron un profundo compromiso con la ecología de los cocodrilos y brindaron valiosos aportes a través de sus diversas áreas de servicio - Juan Carlos (Colombia)

Fue una experiencia muy grata, la temática y las pláticas que se dieron durante este curso me sirvieron mucho para enfocar y encaminar algunos planes a futuro que tengo, además al ser mi primer curso fuera de mi país tuve la oportunidad de conocer gente experta en este tema que en ningún momento dudo en compartir sus conocimientos con los que aún no lo somos y compartir con otros compañeros las diferentes costumbres de nuestras culturas, me lleve un

gran sabor de boca y son cursos que deben de repetirse para que nos podamos integrar a compartir experiencias y conocimientos - Osiris Eguía (México)

Pienso que es muy importante este tipo de iniciativas porque permite que gente con diferentes disciplinas interactúe, se conozcan personalmente, se vean fortalezas en los diferentes campos de acción, de aquí pueden surgir trabajos muy interesantes en diferentes ramas del conocimiento y en pro de la conservación no solo de los cocodrilos, sino de la biodiversidad en general. Me pareció una gran experiencia - John Calderón (Colombia)

Me encantó, la experiencia fue muy fructífera los talleres tanto para aprender acerca del control de las poblaciones, conteo, conservación e incluso aspectos como el comercio que fue aprender sobre la calidad de las pieles. Además, la atención brindada a los asistentes, los espacios amenos y adecuados, la alimentación y el hospedaje - Andrea Rodríguez (Colombia)

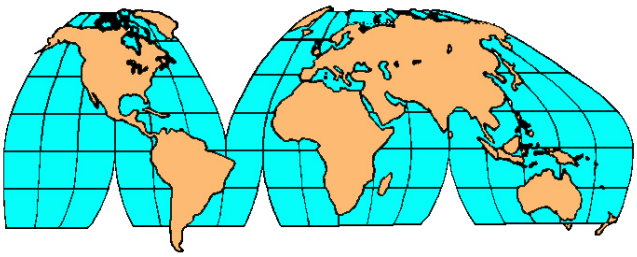
Para la nueva generación, el acceso a la experiencia de los especialistas, así como la capacitación sobre los principios para el estudio, manejo y conservación de los crocodilianos, representa no solo una excelente oportunidad para construir una base sólida de conocimientos en el tema y crear redes de colaboración, sino una poderosa fuente de motivación que promueve la continuidad y la mejora de los esfuerzos de conservación. En última instancia, este tipo de plataformas demuestran que de la pasión pueden surgir no solo conocimientos, sino también un estilo de vida, oportunidades de desarrollo profesional y valiosas amistades - Felipe Hernández (Colombia)

Mi experiencia en el curso fue gratificante, aprendí diferentes perspectivas sobre temas básicos del estudio y manejo de las especies. Fue interesante conocer caimaneras del Atlántico, su gestión y procesamiento de pieles. Pero lo que más me gustó fue reunirme con amigos y colegas, al igual que conocer sobre drones y su uso potencial en el monitoreo de caimanes y cocodrilos en Latinoamérica. ¡Gracias por todo! - Catalina Pinzón (Colombia)

El curso en términos generales me gustó, desde la parte biológica aprendí muchísimas cosas, ya que no estoy familiarizado con esa parte. La parte de drones estuvo muy interesante, pero creo que faltó profundizar en el que se hace después con los datos. En general me gustó mucho, el poder ver ya a los animales, fue muy importante como también manipularlos le dio un buen plus - Nicolás Moreno (Colombia)

Robinson Botero-Arias *(Tropical Conservation Development Program, University of Florida, Gainesville, FL, USA and Wildlife Ecology and Conservation Department, University of Florida, Gainesville, FL, USA; robincrocs@gmail.com)*, Pablo Siroski *(Laboratorio de Ecología Molecular Aplicada (ICiVET - UNL), CONICET, Esperanza, Santa Fe, Argentina and Ministerio de Medio Ambiente y Cambio Climático, Santa Fe, Argentina; cocokaima@gmail.com)*, Felipe Hernández-González *(Grupo de Biodiversidad y Conservación Genética, Instituto de Genética, Universidad Nacional de Colombia, Bogotá DC and Estación de Biología Tropical Roberto Franco, Universidad Nacional de Colombia, Villavicencio, Meta; carhernandezgo@unal.edu.co)*, John Jairo Gómez *(Fundación ORNIAT, Barranquilla, Atlántico, Colombia; potosflavus@gmail.com)* and John Calderón *(Cocodrilos de Colombia, Cartagena, Bolivar, Colombia; jhoncalderon@gmail.com)*.

Regional Reports



East and Southern Africa

Madagascar

CROCS IN THE CLOUDS: HIGHEST ELEVATION RECORD FOR A CROCODILIAN. The Nile crocodile (*Crocodylus niloticus*) is the most widespread of the seven crocodilian species found on the African continent, and is the only crocodilian species found in Madagascar (Jablonicky 2013). Within Madagascar, an estimated population of 30,000 to 40,000 non-hatchling *C. niloticus* are widely distributed throughout the country, being most abundant in freshwater systems bordering the northwestern and western sides of the high plateau, and the northeast of the country (CITES 2016). This species is well known for its seasonal and opportunistic movements during the wet season, where individuals may follow floodwaters and move to seasonal aquatic habitats including creeks and floodplains (CITES 1997). They also inhabit agricultural landscapes and show a fragmented distribution within their range in Madagascar.

Nile Crocodiles are highly versatile in their habitat use. Most populations within Madagascar inhabit freshwater systems such as lakes, creeks, swamps and rivers, and few are found in brackish (CITES 2016) and saline habitats (Behra 2012). Individuals are known to inhabit caves in Ankarana Nature Reserve (Wilson 1987), where they use subterranean rivers as refugia during the dry season. Such versatile habitat usage is also known from other parts of the range of *C. niloticus*. However, the elevational range of this species has been seemingly limited to areas below 1000 m asl (Fig. 1), with few populations found between 1000 and 1500 m asl.

Located at c. 1600 m above sea level (asl), and with a surface area of c. 22 ha, the crater lake Matsaborimena (14°20.5'S, 48°35.4'E) is located close to the village of Bemanevika,

40 km north of Bealanana in northern Madagascar (Figs. 1 and 2). The lake has two seasonal rivers feeding into it and a narrow fringe of marsh and emergent aquatic vegetation, consisting mainly of *Cyperus papyrus* and *Cyperus prolifer* which make up the distinctive surrounding papyrus marsh, a species of *Eleocharis*, and a small patch of *Typha angustifolia* plus other sedges and ferns. Temperatures vary between 10 and 30°C, but during the coldest month (July) night-time temperatures can be closer to 0°C (Bamford *et al*. 2015). The rainy season extends from November to May, with a total annual precipitation up to 2700 mm (Bamford *et al*. 2015).

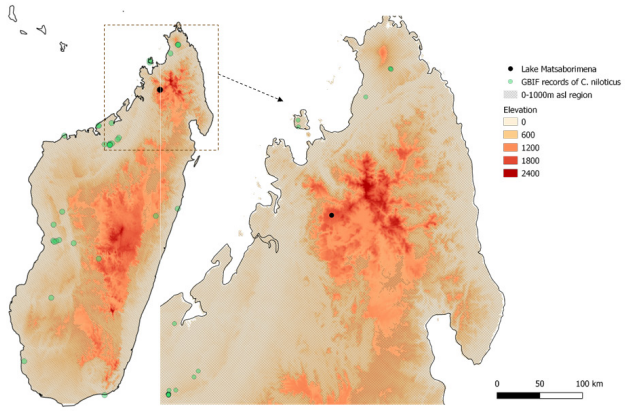


Figure 1. Location and elevation of Lake Matsaborimena in Madagascar (black dot). Records of *Crocodylus niloticus* on Global Biodiversity Information Facility (GBIF) are shown as green dots and the 0-1000 m range is hatched.

Figure 2. Lake Matsaborimena in Madagascar, showing the thick vegetation edging the lake. Photograph: Lily-Arison Rene de Roland.

Lake Matsaborimena has been the subject of many ornithological surveys as it is the site of rediscovery of one of the rarest birds in the world, the Madagascar Pochard *Aythya innotata* (Rene de Roland *et al*. 2007), as well as other endangered and local endemic species such as the Red Owl *Tyto soumagnei*, Meller's Duck *Anas melleri*, Madagascar Serpent Eagle *Eutriorchis astur*, Malagasy Little Grebe *Tachybaptus pelzelnii* and Madagascar Rail *Rallus madagascariensis* (Mills and Rogerson 2013) .

During detailed surveys of the Madagascar Pochard at Lake Matsaborimena, Bamford *et al*. (2015) stated that a small Nile crocodile was occasionally sighted in the lake. The authors also invigilate its role as a potential predator of the Madagascar Pochard. The occurrence of the crocodile was also referenced by Razafindrajao (2020), likely referring to the statements by Bamford *et al*. (2015). However no further information about this crocodile was available.

This record is substantial in a crocodilian perspective and could represent the highest elevational record of a crocodilian globally. Further investigation on the record reveals that the crocodile was first sighted in November 2006 and seen opportunistically during bird surveys until January 2018 (Rene de Roland, pers. obs.). Only the head at the water surface was observed (no observations on land) and the size was estimated at ~2 m in total length. On most occasions the crocodile was closer to the riparian vegetation at the edge. No attempts were taken to approach or photograph the crocodile. Based on the size, it is assumed that the same crocodile was being sighted between 2006 and 2018. In late January 2018, the area experienced a strong cyclone with substantial rainfall, after which the crocodile was not noted.

While Nile crocodiles have a predominantly fish-based diet as they grow (Wallace and Leslie 2008), crustaceans, amphibians and other aquatic and terrestrial animals also play a role in their diet. Lake Matsaborimena lacks any freshwater fish, therefore it is likely that the crocodile was depending on other food sources, including waterbirds. The lake is not used by humans for any purpose, therefore it is unlikely that the existence of a crocodile is problematic for any community. Given the lack of human use of the lake, potential historical occurrence of crocodiles in the lake is not known.

The origin of the individual at Lake Matsaborimena is unknown. Based on publicly available records on the Global Biodiversity Information Facility (GBIF), the closest records of Nile crocodiles are over 100 km away (Fig. 1). The lake is connected to a local river by a small canal, therefore it is possible that crocodiles naturally ascended to the crater lake. A search of records on publicly available datasets and published literature did not result in any records of crocodiles at elevations above ~1000 m asl in Madagascar. Nile crocodiles are farmed in the capital Antananarivo (~1300 m asl) (Jenkins *et al*. 2006), but the species does not naturally occur there. Attempts to farm crocodiles in other parts of Madagascar have failed, therefore it is possible that escapees from a farming/ranching attempts have reached Lake Matsaborimena. There have also been intentional releases of captive-raised Nile crocodiles, including adults, hatchlings and juveniles, in the northeast of the country, but these occurred in 2011 (CITES 2016), well after the first reported sighting in Lake Matsaborimena in 2006. The possibility of someone releasing the crocodile (perhaps when young) to the lake cannot be ruled out either.

Records of crocodilians at high elevations are rare. It is possible that movements into high elevations are limited by geographical features such as waterfalls and escarpments.

The colder temperatures at higher elevations, particularly in winter, are a key factor affecting distribution, as they impact on the ability of crocodiles to effectively thermoregulate and also nest (egg incubation). Limited food resources, such as large freshwater fish at higher elevations, may also restrict crocodile populations sustaining populations.

Other notable high elevation records for crocodilians are from rainforest stream-dwelling *Paleosuchus* species from South America. Gorzula and Paolillo (1984) reported the occurrence of Schneider's smooth-fronted caiman *Paleosuchus trigonatus* at 1340 m asl in Guyana Venezolana, although the species is principally restricted to oligotrophic forest streams from 100 to 1200 m asl (Seijas 2007). The often sympatric Cuvier's smooth-fronted caiman *P. palpebrosus* has been recorded up to 750 m asl (Medem 1981). Other unusually high records for a particular species include a population of Gharial *Gavialis gangeticus* in the Kopili Reservoir on the border of Megahalya and Assam at c. 750 m (J. Lang, pers. comm, 2023) and Siamese crocodiles *Crocodylus siamensis* in Cambodia at c. 600 m (Sam *et al*. 2015).

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Latin America & the Caribbean

Belize

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Helena Wood-Barron, *Sarasota, Florida, USA*.

UTILIZING UAV TECHNOLOGY IN CROCODILE CONSERVATION AND MANAGEMENT IN BELIZE. Unmanned aerial vehicles (UAVs), more commonly known as drones, come in all shapes and sizes, from a fixed wing arrangement to a rotary wing arrangement or even a combination of the two. They can provide numerous benefits to aid in animal conservation, particularly because they are very affordable and portable, unlike manned aircraft traditionally used for population surveys (eg helicopters, light aircraft). UAVs have been used in a variety of conservation-related purposes, such as mapping of habitats, population surveys, individual tracking, anti-poaching patrols and much more.

Whilst in the air, UAVs can cover a wider survey area than several surveyors on the ground and provide high resolution imagery which can be processed manually or using software. Not only can UAVs take RGB color imagery, but they can be fitted with cameras that can photograph in different light spectrums such as infra-red, thermal and ultraviolet. This means that UAVs can utilize these spectrums to capture unique insights and engage in alternative survey methods such as surveying animals at night via thermal imagery.

In September 2019, a video went viral throughout Belize, of an adult Morelet's crocodile (*Crocodylus moreletii*) in Orange Walk Town going towards a group of boys at a rapid pace and grabbing one of their small dogs. Although it is not unusual for crocodiles to attack dogs, the behaviour of this crocodile was that of familiarity and no hesitation. In Belize, Morelet's crocodiles are generally timid and wary of humans, particularly given continual (illegal) hunting and harassment. Even around towns or areas where the Morelet's crocodile population is dense and used for eco-tourism, crocodiles tend to swim away from humans, not towards them. The bold behavior and deliberate approach of this crocodile towards this group of boys was unusual for crocodiles in this area.

Shortly after the incident, it was discovered that these boys had been feeding this crocodile over the last several months. Given the animal was considered habituated and now represented a potential danger to humans, the Belize Forestry Department (BFD) requested the animal be removed and placed in the Crocodile Research Coalition (CRC) rehabilitation program for possible future release back into the wild.

The New River has one of the highest densities of Morelet's crocodile in Belize (unpubl. data), and several adult crocodiles have been observed around the river banks of Orange Walk Town. We did not want to set up a trap and accidentally capture the wrong crocodile. In our experience, if there are several crocodiles in an area and they observe a crocodile getting caught in a trap (whether baited traps or use of bobbers), these animals will become wary of humans and other traps, therefore, increasing the difficulty of catching the suspected crocodile (several crocodile nuisance hunters or trappers internationally have confirmed similar experiences). As the CRC had access to video of the crocodile attack, we examined the footage and identified several unique marks/scars on the crocodile's head that would assist in identifying it.

Seven days after the incident, we flew a DJI Phantom 4 drone over the area, from 1500 to 1730 h. In a 100-m stretch of the river we observed several adult crocodiles swimming with their heads fully visible at the water's surface. We compared visible facial marking and scarring patterns from images captured of the target crocodile, and identified one crocodile with similar markings to that in the video. We flew the drone around the crocodile for several minutes to confirm that the markings on its head matched the markings from the video. We were able to get the drone as close as 5 m above the crocodile as it was floating on top of the surface, before it submerged and swam away. After confirmation, we continued to fly the drone for ~30 minutes to generally observe the crocodile's activity and to identify a general area to direct capture effort based on crocodile movement and use of the particular river section.

Later, still during daylight hours, CRC staff tried to lure the crocodile by reenacting direct feeding (by putting a piece of coconut on the end of the rope and slapping the water as if it were food like chicken), but it did not respond. At sunset, we took a boat to the identified area, and caught the animal via noose within minutes of arriving in the crocodiles' territory.

After capture, we safely restrained the crocodile to obtain morphometric data. The crocodile was an adult male with a total length of 191.2 cm (Fig. 1). We compared the markings on the head to that of the video and confirmed that we had captured the crocodile responsible for the attack. Interestingly, these markings were not scars, but areas of the skin that were turning white. This capture initiated our ongoing investigation of the White Walker crocodiles of New River, where a cocktail of chemical run-off from industry and agriculture is thought to be causing discoloration of the crocodiles' skin (Marin 2020).

Traditional methods of capturing problematic or habituated crocodilians (crocodilians which have become habituated to humans due to a human-induced change of behaviour, such as via direct or in-direct feeding) include baited traps that do not necessarily target the specific animal of concern. If an individual around the same size as the targeted animal is captured, the people or agencies involved may wrongly consider that the targeted problem animal has been caught.

Figure 1. Targeted *C. moreletii* after capture. Photograph: David Hilmy.

Personal communication with nuisance hunters or trappers from different countries and agencies revealed how such methods have caused the destruction of non-problematic crocodilians that were not necessarily a threat. More importantly, the capture of the "wrong" crocodile may result in a false sense of security to a community. Though we acknowledge that these considerations are species and context dependent, targeted removal is a valuable practice applied where other large fauna come in conflict with people (Swan *et al*. 2017).

In the case study here, the combination of video footage and use of a drone allowed the specific problem crocodile displaying habituated behavior towards humans, to be located and captured relatively quickly, without other crocodiles in the area being interfered with. In this era of smartphones, images or videos of the targeted crocodilian may exist. If so, images can be analyzed to identify unique features and ensure the correct animal is removed.

The use of drones also allows for the profiling of areas of human-crocodile conflict, and allowing for rapid assessment of the relative abundance and size distributions of sympatric crocodiles where conflict occurs. This can be used to conduct follow-up outreach and temper false sense of security by reinforcing cohabitation strategies that may mitigate future conflict. To further coexistence and conservation of crocodilians, emphasis must be placed on how we respond to negative interactions between crocodilians and communities as an inappropriate response to crocodile conflict may damage public perception and negatively impact coexistence.

Acknowledgements

We would like to express our gratitude to BFD and Lamanai River Tours for assistance in the capture of the targeted crocodile in this report, as well as thank you to the community of Orange Walk Town for contacting BFD and CRC in regards to the crocodile attack.

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CRC CELEBRATES CROCTOBER. Although science and research play an important role in conserving species, community support and interest have been fundamental principles for the Crocodile Research Coalition (CRC), helping it move closer to its conservation goal. This year, the CRC celebrated "CROCtober" with the theme: "Coexisting with Crocs, it's the Belizean Culture".

For us at the CRC, this is the time of the year when we put down our headlamps and kayaks, and prioritize educational outreach throughout our community, as well as country-wide, squashing misguided beliefs and false facts about the two species of crocodile in Belize - Morelet's (*Crocodylus moreletii*) and American (*C. acutus*) crocodile. Our Program Coordinator Monique Vernon attended Zoom meetings, virtual radio and TV morning shows, conducting outreach presentations to schools, resorts, and businesses, and sharing interactive social media posts hoping to spark interest and tolerance towards communities, garnering their interest to participate in conservation action (Fig. 1).

Figure 1. Program Coordinator Monique Vernon with youth at the Seine Bight Library.

Much of the folklore, knowledge, and respect towards crocodiles by the original inhabitants (the Maya) and then first settlers has been lost due to colonization, and more recently, modernization and now the dramatization established by Hollywood. To counteract misrepresentation of our species of crocodiles and to revitalize stories and connections that communities have with crocodiles, the CRC conducted interviews with several local people at Placencia Lagoon and posted these stories on our social media outlets.

Our anticipation was by involving community members in our educational efforts, we can ensure local stories and knowledge may be passed on, furthering interest and pride in our local crocodiles.

In summary, the CRC hosted 13 outreach presentations, 3 TV/radio appearances, submitted two news media articles, posted daily educational social media croc posts to our platforms, reaching over 2600 people in just one month. In addition, we held three fundraisers, two of which were organized and supported by local businesses, and which included: a 50/50 raffle promoted for the month of October at Sirenian Bay; a drink created by Sirenian Bay, named the "Croc-tail", with proceeds donated to the CRC; a kids Halloween party organized at The Flying Pig in which entrance fee was donated to the CRC's wildlife youth program "Next Gen Croc"; and lastly, a Croc Run fundraiser (see following article).

Overall, all of these outreach events provided us a way to interact with communities near and far, allowing us to provide facts about the wonderful world of crocodiles, while also educating about the laws set to protect them, in addition to tips on how to co-exist with crocodiles to further pride and stewardship.

Monique Vernon, *Crocodile Research Coalition, program (coordinator@crcbelize.org)*.

CRC CROCTOBER CROC RUN FUNDRAISER. As part of the Crocodile Research Coalition's (CRC) CROCtober educational outreach events, and to bring awareness to the conservation efforts for crocodiles in-country, the CRC hosted its first ever "Croc Run" on 22 October 2023 (Fig 1). There were more than 80 runners (including a few international competitors) on the Placencia Peninsula to compete in either a 5-km fun run, or half marathon (21 km) race. For the 5-km run, there were 30 runners from the local youth running club (Seine Bight Running Club), whose registration fees were sponsored by various community members.

Figure 1. Croc Run 2023 participants. Photograph: Belize My Travels.

Leon O'Brien of Belize City won the half marathon for men, and Ana Lopez of Esperanza won the half marathon for women. Both winners received cash prizes, and handmade crocodile carvings made by a local artist. All runners (in-person and virtual) received wooden medals commemorating the event.

The Croc Run raised over $US4000 for the CRC's wildlife youth program "Next Gen Croc", as well as for educational outreach efforts around CRC's homebase, Placencia Lagoon. Funds were raised from dozens of national and international sponsoring organizations (such as Chabil Mar, The Belize Collective, Wild Florida and The Crocodile Foundation to name a few). The CRC is grateful for the local and international support, and the community along with the CRC is already looking forward to Croc Run 2024 to further outreach and awareness for crocodiles (Fig. 2).

Figure 1. CRC staff and volunteers who assisted in organizing and working the Croc Run 2023. Photograph: Sarah Aly Photography.

Jane Champion, *Crocodile Research Coalition (research.coordinator@crcbelize.org)*.

Europe

Ireland

ASSESSING *EX-SITU* WELFARE USING MODIFIED SPREAD OF PARTICIPATION INDEX (SPI) ANALYSIS, *IN-SITU* BEHAVIOUR BIOLOGY RESEARCH AND RECORD KEEPING. Since 1982, modified Spread of Participation Index (SPI) has been used as a statistical measurement for assessing space utilisation of animal enclosures based on biological functions (Plowman 2003). The biological functions are derived from species-specific *in-situ* behavioural research. This is imperative when it comes to measuring welfare in *ex-situ* environments because it offers a baseline from natural ecosystems. These understandings, in addition to historical records of individuals, can offer means of monitoring and improving welfare for individuals in captivity.

The aim of this research was to assess the welfare of an individual American alligator (*Alligator mississippienisis*) through modified SPI, using *ex-situ* behavioural observations and individual record keeping. The study was conducted at

The National Reptile Zoo in Kilkenny, Ireland, from 2 April to 31 May 2021. The alligator is a male, that had originally been imported into the UK in 1995, and had been held by a circus for approximately 7 years before being given to The National Reptile Zoo in 2008. He is now 3.2 m in length.

Data were collected using two camera traps (Browning Trail Cameras: Model BTC-7A), placed in the animals' enclosure (see Fig. 1). Modified SPI was used to compare the observed frequency of the different enclosure areas (zones), with the expected frequency, given their sizes (Fig. 2). This approach enabled measurement of behaviours in each zone (Hosey *et al*. 2009). The camera traps (numbered 1 and 2) were placed in positions that allowed coverage of most of the enclosure, and they remained there throughout the study, with only the batteries being changed as required. Cameras detected movement, and took an image (= data). Diving behaviour was not included as the camera traps were not waterproof.

Figure 1. The *A. mississippienisis* enclosure at The National Reptile Zoo. Camera trap locations are marked as red dots (Camera 1 left; Camera 2 right). Photograph: James Hennessy.

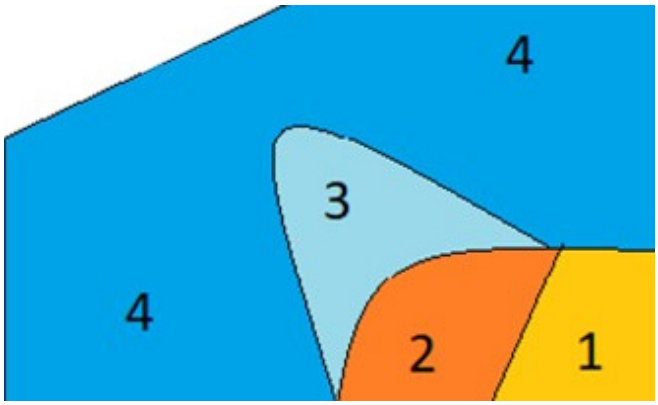

Figure 2. Zones for Modified SPI.

The enclosure is approximately 81 m^2 (9 m x 9 m). The four zones were decided on the *in-situ* behaviour research: Zone 1= land area with heat lamps; Zone 2= land area without heat lamps and up to water's edge; Zone 3= shallow water; and, Zone 4= deep water.

The two heat lamps were 2000W infrared A heat emitters. The four UV lights were 12% UVB Arcadia T5 56W bulbs, supplemented by 4 LED flood lights with a color temperature of 5000K. All of these are on a 12 hour day and night cycle, and supplemented in the summer by extended daylight entering the building.

In summer (April-October), ambient temperature is 28°C and under heat lamps in Zone 1 it is 40°C. In winter (November-March), ambient temperature is 12°C and under the heat lamps it is 25°C. Water temperature was 22°C between April and November (J. Hennessy, pers. comm.).

SPI was calculated as: SPI= (∑[Fo - Fe])/2(N - Fe min), where "N" is the total number of observations in all zones, "Fo" is the observed frequency of scans in each zone, "Fe" is the expected frequency for each zone, and "Fe min" the expected frequency in the smallest zone.

Expected frequency was used because the zones were not of equal size, and it is based on the zone size assuming even use of the whole enclosure. SPI has a value between 0 and 1, with 0 being that the zones are more equally occupied and 1 being that zones are more favored than others (Plowman 2003). Excel was used to form an ethogram of the data.

Table 1 shows the five observed behaviours and their descriptions.

Results and Discussion

The Modified SPI was calculated 0.51, and thus leans neither towards the zones being used equally (0) or favored compared to other zones (1). However, when breaking down the results of the observed and expected frequencies individually for each zone, it is clear that Zone 1 is favored because it has the highest observed frequency (Fig. 3).

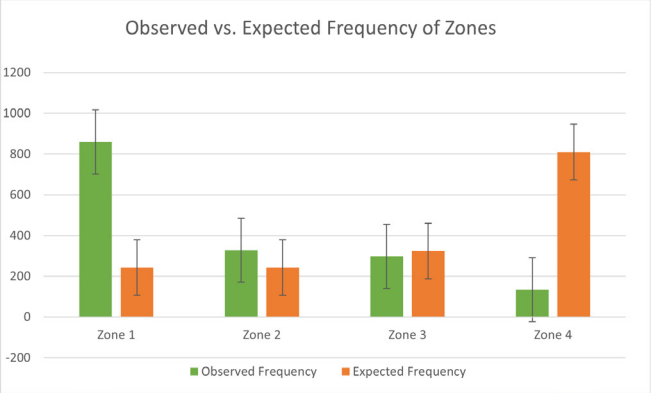

Figure 3. Observed versus Expected Frequencies of the enclosure zones.

Zone 1, comprising 15% of the enclosure area, was utilised more than expected (OB= 904, EF= 245.7). This zone is directly underneath the heating lamps, and where the alligator spent 73% of its time (Fig. 4). Wild *A. mississippiensis* also spend a lot of time basking in the sun during this time of year to increase metabolism and aid digestion of food, etc. They also use shaded areas and different vegetation and soils (Grigg and Kirshner 2015). A result of 73% underneath the basking lamp is an expected behaviour during April and May as this is when the alligator comes out of aestivation.

Table 1. Description of behaviours observed. HOTA= Head Oblique Tail Arched.

Behaviour	Description
Minimum Exposure Posture (MEP)	Still motion or gliding across the surface of the water with only the head exposed
Mouth Open/Teeth Display	Occurs during thermoregulation and when threatened
Basking	Thermoregulation under the heat lamp
Feeding	Alligator fed by keepers in the enclosure
Vocal Communication/HOTA Posture	HOTA posture and vocalisations in the water cause vibrations that are visible through ripples and bubbles

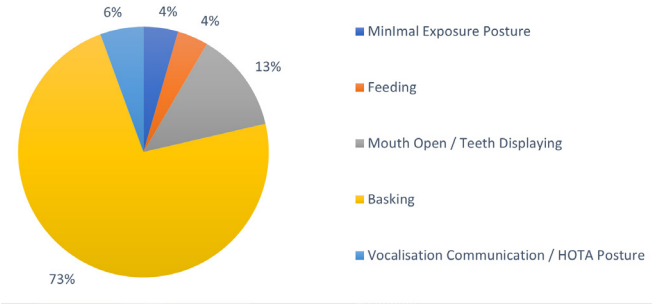

Figure 4. Frequency of observed behaviours.

The water temperature at The National Reptile Zoo remains at 22°C from April to November, and the Infrared A emitters can reach up to 40°C, with an ambient temperature on average 28°C. This corresponds to the metabolic function temperature requirements of *A. mississippiensis* of 25-36°C (Grigg and Kirshner 2015).

Of the behaviours observed (Table 1), Minimum Exposure Posture (MEP), Mouth Open/Teeth Display, Feeding and Head Oblique Tail Arched (HOTA) Posture are all behaviours that can occur in the water (Zone 4, the water body of the enclosure, comprised 45% of the area).

MEP, which represented 4% of the data (Fig. 4), can serve multiple functions. These include patrolling, hunting and hiding when threatened (Grigg and Kirshner 2015). As the alligator in this research has been in *ex-situ* most of its life, it can be assumed that it was used to daily "disturbances" from visitors and feeding. However, *in-situ* results shows the alligator began to feed in May, building up to a peak activity and feeding during July, August and September, before slowing down again. This is why MEP made up such a low proportion (4%) of the observed behaviours.

When MEP is high in *ex-situ* crocodilians, potential causes should be explored to reduce stress, which can aid management decisions on the *ex-situ* environment (Morgan and Tromborg 2007). When MEP occurs during feeding, this may indicate that the instinctive behaviours are being stimulated and the activity and approach is potentially enriching.

One of the times that Mouth Open/Teeth Displaying behaviour occurs is when the animal is faced with a threat (Grigg and Kirshner 2015). In this study it represented 13% of observed behaviours (Fig. 4).

The occurrence of the Mouth Open/Teeth Displaying behaviour appeared to follow a pattern when the alligator was under threat. Teeth Displaying behaviour would come first, then when the level of threat increased; Mouth Open behaviour would occur, followed by retreat into the water. This suggests that the more the alligator felt threatened, the wider the mouth was open, perhaps aiming to display a bigger defense.

Data from Camera 1 indicated that a keeper was in the enclosure 5 times. On two occasions, the keeper was feeding the alligator and it was teeth displaying - the longer the keeper was in the enclosure the wider the animal opened its mouth.

Data from Camera 2 indicated there were 44 intervals of visitors/staff seen at the viewing window. On four occasions, there were visitors/staff close to the window and directly looking at the alligator. On 3 of these occasions the alligator moved from Zone 1 (heating lamp) to Zone 4 (water). This behaviour is associated with the alligator being trained to go to the window before being fed, enabling the keeper to safely enter the land area to feed.

Mouth open/teeth displaying behaviour occurred during the night in Zone 1, when there were no visitors or staff in the building. This suggests potential vocalisations associated with the breeding season (April and May; Stevenson 2019), as well as a potential threat response behaviour (Grigg and Kirshner 2015). Although the camera traps didn't record sound, the HOTA posture and vocal communication were recorded in 6% of the data (Fig. 5). This is when intraspecific mating vocalisations were evident, when the alligator was in the HOTA posture in Zone 4 with ripples and bubbles present on his back (Table 1).

Zoo staff have reported that the alligator vocalizes when loud cars go past. In *ex-situ* environments, they can become accustomed to noises as they are predictable. However data shown unpredictable potential response to noises, this was during the night when there are no staff in the building. suggesting that the alligator was responding to a noise it didn't recognize. Without record keeping and research, responses such as this one this may be confused with other environmental influences, or it could be assumed abnormal.

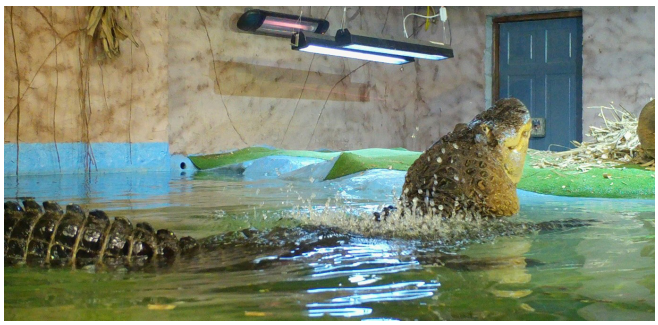

Figure 5. Alligator in HOTA posture, showing subaudible/audible sound through vibrating of the flanks which are evident from ripples and bubbles on its back.

Record keeping allows us to understand reasons for behaviours, which contributes to the welfare of individuals (Rees 2011).

This research was of a single individual, and highlights ways in which a combination of modified SPI, *in-situ* behaviour biology research, and record keeping can all direct enclosure designs, validate enrichment approaches and indicate potential stresses with species-specific and individual animals. Therefore, initiating and maintaining regular behaviour observations with *ex-situ* individuals using these methods can improve animal welfare. When sharing these methods, we can improve our collaboration with each other in making management decisions, and guide future research and education in *ex-situ* welfare

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South Asia and Iran

India

PARTIALLY-WHITE CROCODILES OF BHITARKANIKA NATIONAL PARK (ODISHA, INDIA), WITH SPECIAL REFERENCE TO A CAPTIVE CROCODILE. During a population study of Estuarine crocodiles (*Crocodylus porosus*) inhabiting the tidal mangrove creeks of Bhitarkanika Wildlife Sanctuary/National Park in undivided Cuttack district (now Kendrapara district), Odisha, the presence of several partially-white crocodiles was noted (Bustard and Kar 2019; Kar and Bustard 1989; Kar 1981). These individuals are well known to the local people, who consider that they are a distinct "species" of crocodile (Figs. 1 and 2), which they refer to as "Sankhua" (which means whitish-conch coloured in the Odia language), to distinguish them from typical *C. porosus* (known as "Baula" in Odia).

Figure 1. Partially-white female Estuarine crocodile of 2 m length in Hansina River, during first census in December 1976. Photograph: Sudhakar Kar.

Figure 2. Partially-white female Estuarine crocodile of 3 m length on banks of main Bhitarkanika River. Photograph: Nimai-Bhakta.

Like the so-called "white" tigers of former Rewa state in Central India (now part of Madhya Pradesh), the "white" crocodiles are not albinos since they possess the typical black markings (spots or blotches, and stripes in crocodiles and tigers, respectively). However, they both completely lack pigment in the background colour.

At the time of the crocodile census in December 1976 and January 1977, 35 adult and sub-adult *C. porosus* inhabited the sanctuary, four of which were partially-white (Kar 1989). As of the January 2023 census, there were 16 partially-white crocodiles (Kar 2023), representing different size classes (hatchling 1, yearling 2, juvenile 3, sub-adult 3, adult female 4, adult male 3).

In adult crocodiles, the background colour is not as white as it is in hatchlings, since like other large reptiles, the colouring in *C. porosus* becomes dull with increasing size and age. Local people state that in very large (old) crocodiles the whitish colour of the body may become so dull as to be indistinguishable from normal-coloured crocodiles. The face, however, remains "white" throughout life.

It could be assumed that the survival prospects for such individuals in the wild would be poorer than for normal-coloured individuals. However, there is evidence from local people of their occurrence in the Bhitarkanika mangroves over a long period of time, and that they can recruit into the breeding cohort of the population.

On 20 July 1975, a clutch of 48 eggs was collected from Kalibhanjadian within Bhitarkanika Wildlife Sanctuary/ National Park for incubation at the Dangmal Estuarine Crocodile Research Centre. The nesting female was thought to be a 4.0-4.3 m partially-white crocodile (Kar and Bustard 1982). The clutch produced 24 hatchlings on 21-23 August 1975, one of which was partially-white like the nesting female - it was named "Gori" (Figs. 3-5), and confirmed to be a female when about 1 m in length.

Gori has been housed in a separate pool at the Dangmal Research Centre and this pool is connected to the nearby natural creek to facilitate tidal flow into the pool. She is currently fed 6 days per week, with daily feed comprising 0.5 kg fish and 5-6 mud crabs (*Scylla serrata*; 0.8-1.0 kg). Local mangrove species such as Kharakhari (*Acrostichum aureum*), Hental (*Phoenix paludosa*), Sundari (*Heritieria minor*) and Bania (*Hibiscus tiliaceus*) have been planted in the open space surrounding the pool (Fig. 5). These keep the water cool during summer and also provide shade.

First time nesting for Gori occurred in 1985, when she laid 16 infertile eggs, at the age of 9.83 years. Three young captive males, one year junior to Gori, were subsequently introduced into her enclosure in 1987, 1988 and 1989, respectively - but all three were killed by Gori. In 1990, a wild male that was slightly bigger than Gori was introduced into her pool, but she did not accept him. There was a lot of fighting and Gori was severely injured by the male, resulting in her receiving treatment and care for over two weeks. She recovered, but her right eye was partially damaged. Since then, no male crocodile has been released into her pool, although attempts have been made to locate a compatible captive male.

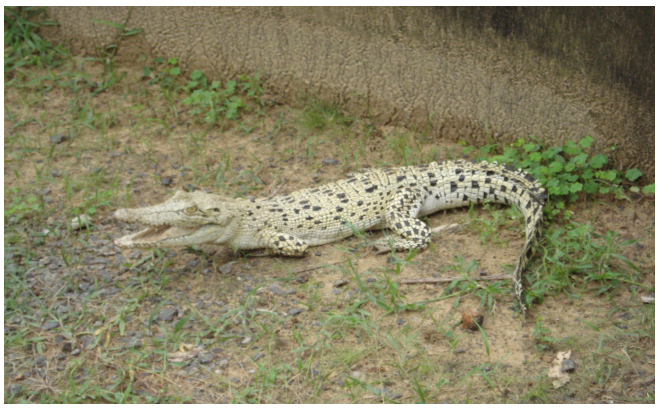

Figure 3. Gori at about 1.5 m length. Photograph: Sudhakar Kar.

Figure 4. Gori at 9 years of age and 2.5 m length. Photograph: Sudhakar Kar.

Figure 5. Gori feeding on mud crabs in her breeding pool. Photograph: Sudhakar Kar.

Since 1985, Gori has nested irregularly, with intervals of 2-4 years between nesting events. Clutch size has varied between 16 eggs (in 1985) and 51 eggs (in 1992), and mean clutch size is 34.3 eggs (N= 19; 1985-2023). The latest clutch was laid on 24 June 2023, comprising 34 infertile eggs, and as usual she actively guarded the nest.

Gori is now 48 years old, 2.8 m in length and 78.0 kg in

bodyweight. She has survived without any hint of "genetic" issues related to her skin colour, and grown well in captivity. Unfortunately, the inability to pair her with a male for breeding purposes has not allowed us to look at the heritability of this colouration in detail. That Gori's "mother" was a thought to be a partially-white individual suggests some level of heritability.

Of the 2740 hatchlings produced in 1975-2003 at the Crocodile Research Project incubator, Gori has been the only one to exhibit the partially-white colouration.

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Pakistan

REDISCOVERY OF THE CRITICALLY ENDANGERED GHARIAL (*GAVIALIS GANGETICUS*) IN PUNJAB, PAKISTAN. The global decline of reptile populations is a matter of growing concern, with consequences for ecosystems and biodiversity conservation. Numerous factors have contributed to this alarming trend, including habitat destruction, climate change, pollution and poaching (Gibbons *et al*. 2000; Böhm *et al*. 2013). The most severe and rapid declines of Pakistan's reptilian fauna have also been attributed to climate change, disease, introduced species and habitat loss and degradation.

The geographical and climatic diversity of Pakistan makes it a hotspot for reptilian diversity, with approximately 195 documented species, 13 of which are endemic to the country (Khan 2006; Ali *et al*. 2018). However, these reptiles are under significant threat due to habitat degradation, illegal collection for the pet trade and a lack of adequate conservation measures (Ali *et al*. 2018). Population declines and extirpations that have occurred over the last several decades in Pakistan were not always obvious, because few reptilian populations were monitored during the die-offs.

The Gharial (*Gavialis gangeticus*) is a critically endangered crocodilian (IUCN 2023; Lang *et al*. 2019) with a limited distribution. Gharials were formerly distributed in all the major river systems of the Indian sub-continent, spanning from the Indus in Pakistan to the Irrawaddy in Myanmar (Whitaker and Basu 1982). But presently, they are confined to few river systems of Nepal and India - Rapti, Narayani, Babai, Karnali of Nepal and Chambal, Girwa, Son, Ramganga, Gandak and Mahanadi of India (Malla *et al*. 2012; GCA 2008) - and are considered virtually extinct in Pakistan, Bhutan, Bangladesh and Myanmar.

Historically, the species was known to inhabit the Indus River system in Pakistan. However, over time, reports of Gharial sightings became scarce, leading to concerns of local extinction (Ahmad 1990; Chaudhry 1993; IUCN 2023). The collapse of Gharial populations is likely due to complex factors that vary in importance by region (Khan 1998). Gharials are listed on Appendix I of CITES, and in Pakistan are protected under Third Schedule of the Punjab Wildlife (Protection, Preservation, Conservation and Management) (Amendment) Act, 2007.

Throughout their current range, Gharials face numerous threats, the most significant of which are habitat destruction and deterioration, mortality due to destructive fishing methods and prey depletion as a result of over-fishing. With increased human population, pressure around riparian habitat has become tremendous, leading to practices unfavourable to Gharials, such as fishing, sand and gravel mining, stone quarrying, dam construction, electrocution, poisoning, livestock grazing, encroachment of riparian habitats, land use changes and river pollution (Malla *et al*. 2012; Braulik *et al*. 2014). The species is also at risk from flow regulation as it prefers fast flowing river habitats that are also prime sites for dams. The construction of dams prevents the upstream movement of Gharials (Dudgeon 2000; Braulik *et al*. 2014).

Historically, in Pakistan the species was reported in the Sindh region (Ahmad 1990; Chaudhry 1993). However, as of 2008-2009, extensive surveys conducted by WWF-Pakistan under the "Indus for All Programme and Pakistan Wetlands Programme" conceded no indication of Gharial presence (PWP 2012). However, the situation took a surprising turn in May 2023, when a video began circulating on social media,

showing a Gharial trapped in a fishing net in the area of the Sutlej River near Head Ganda Singh Wala in District Kasur, Punjab Province.

Following these reports, WWF-Pakistan's wildlife team in collaboration with Pakistan Wildlife & Parks Department (PW&PD) visited the area to investigate further. The aim was to conduct field surveys to confirm the presence of Gharials in the area, conduct interviews with local farmers and fishermen to determine the distribution of Gharials in the Sutlej River, and provide recommendations and outline immediate actions necessary for the protection of this critically endangered species in Pakistan. Preliminary surveys were conducted on 16-18 May 2023.

Field surveys efforts for Gharial were focused at the Head Ganda Singh Wala (31° 2' 16.71"N, 74° 31' 6.47"E) area in the Sutlej River, located 18 km from Kasur city and 58 km from Lahore city, in District Kasur. The Kasur District is surrounded by the Ravi River in the northwest and the Sutlej River in the southeast. The district has Indian territory on the south and east across the Sutlej River, Lahore district on the north, Okara district on the southwest and Nankana Sahib district on northwest (DDMP 2022).

Average annual temperature is 23.9°C and annual precipitation is 424 mm in this area. Precipitation is the lowest in November (average of 3 mm), and greatest in July (average of 125 mm). Similarly, June is the hottest month of the year (average of 33.7°C), and lowest temperatures occur in January (around 12.2°C) (DDMP 2022).

The Sutlej River flows through the historic crossroads region of Punjab in northern India and Pakistan. The waters of the Sutlej River are allocated to India under the Indus Waters Treaty between India and Pakistan. Continuing west-southwest, the Sutlej enters Pakistan about 15 km east of Bhedian Kalan, Kasur District in Punjab Province. About 17 km north of Uch Sharif, the Sutlej unites with the Chenab River at Head Panjnad, which finally flows into the Indus River about 100 km west of the city of Bahawalpur. The Sutlej River enters into Pakistan at Head Ganda Singh Wala, and the area is prone to flooding.

The Sutlej River flows through the region, surrounded by lush riparian vegetation, providing critical habitats for a variety of wildlife. The area is generally from 150 to 200 m asl (DDMP 2022). Human habitation, primarily engaged in traditional agriculture and fishing, coexists with this rich natural world. The area's environmental conditions are influenced by the river's seasonal fluctuations, creating a dynamic ecological balance vital for its diverse species. This unique combination of water, vegetation, wildlife, local inhabitants, fishing activities, and changing environmental conditions shapes a critical and complex ecosystem. Within this setting, the rediscovery of the Gharial offers hope for both species' preservation and sustainable coexistence with the local communities.

Locations of Gharials sighted during the surveys and also reported by local fishermen are on Figure 1. The surveys confirmed the presence of 8 juvenile and two adult Gharials near Head Ganda Singh Wala. Juveniles appeared to be around one year of age (ie from previous breeding season), and one of the adults was a male (with ghara). These Gharials were sighted directly at 1745 h on 16 May 2023, but not photographed due to it being a restricted area.

Figure 1. Locations of Gharial sighted at Head Ganda Singh Wala and Dhupsari village.

Indirect signs of Gharial, such as footprints and markings on riverbanks were also recorded on the riverbanks. Fishermen had also observed Gharials basking many times, suggesting that Gharials were active in the vicinity.

With the help of local fishermen we used a drag fishing net to sample fish from the area to assess potential predation by Gharials. We found evidence of attempted predation by Gharial on fish (Fig. 2).

Figure 2. Gharial bites on fish captured at Head Ganda Singh Wala.

A total of 20 interviews of local farmers and fishermen were done, about the presence, distribution and their encounters with Gharials in the Sutlej River. Of the 20 interviews, 17 confirmed the presence of Gharial in the Sutlej River over the last two years (2022-2023). They revealed that they had observed 10-12 individuals, including juveniles, in the first week of May 2023 near Head Ganda Singh Wala. In July-August 2022 they had seen 3-4 adult Gharials (local name "Sansaar") in the Sutlej River near Sulemanki Headworks in District Okara. On 5 May 2023, one sub-adult Gharial entangled in a fishing net near Head Ganda Sigh Wala was captured by fishermen, and then released in the Sutlej River (Fig. 3). On 16 July 2023, one adult Gharial was sighted by fishermen near Dhupsari village, 17 km from Head Ganda

Singh Wala towards Head Sulemanki.

Figure 3. Sub-adult Gharial that had been entangled in fishing net near Head Ganda Sigh Wala; captured by fishermen and then released in the Sutlej River.

Khan (2006) was of the view that Gharials were extremely rare, if not absent in Pakistan, this is why nothing definite can be said about the species' distribution in Pakistan. Ahmad (1986) reported 2-3 Gharials between Sukkur and Guddu barrages in Sindh. Similarly, there is evidence in support of the existence of a population in the lower Indus, the East Nara in Sangha District, Sindh (Mertens 1974; Ahmad 1985). The direct sightings of both adults and juveniles during our surveys, and information provided by local fishermen over the last two years at different locations, indicate that Gharials are breeding in the Sutlej River.

Local farmers and fishermen are anxious about the presence of Gharials in the area, and consider the Gharial to be a dangerous animal which can injure them and their children. A majority of the local population expressed fear about Gharial presence and expressed a desire for their removal and/or relocation to another area. Few of them emphasized the urgent need for protective measures, both for Gharials and the safety of the human inhabitants. These opinions highlight the complex relationship between wildlife conservation and the concerns and perceptions of the local community.

This rediscovery, therefore, raises crucial questions about the factors influencing the species' persistence in the face of habitat alterations, anthropogenic pressures, and potential human-wildlife conflict issues.

WWF-Pakistan, in collaboration with PW&PD, initiated proactive measures, with a committee being established to provide recommendations. The committee recommended:

1. to designate the potential area of the Gharial's presence and sightings as Gharial Wildlife Sanctuary;

2. impose a ban on fishing activities in the potential core zone area (5 km) of the Gharial's presence from Head Ganda Singh Wala towards Head Sulemanki;

3. undertake a comprehensive scientific assessment of river stretch from Head Ganda Sigh Wala to Head Sulemanki to obtain more information about Gharial's presence in the area;

4. develop a communication strategy and conduct awareness campaigns to sensitize local farmers and fishermen about the importance of Gharials and their ecological role in the ecosystem to mitigate potential future human-wildlife conflict issues; and,

5. establish a captive breeding facility for Gharials at Head Sulemanki.

Based upon the recommendations of the committee, and recognizing the significance of the area, the Government of the Punjab through a notification dated 21 July 2023, in exercise of the powers conferred vide section 9 of Punjab Protected Areas Act 2020, notified a 70-km strip of the Sutlej River from Head Ganda Singh Wala, District Kasur towards Head Sulemanki, District Okara along with one kilometre width on both sides of the river as Gharial Wildlife Sanctuary (Fig. 4). The relevant authorities also imposed a ban on fishing activities to mitigate potential conflicts with Gharials and to ensure the safety of local communities.

Figure 4. 70-km stretch of the Sutlej River designated as Gharial Wildlife Sanctuary.

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North America

USA

5TH PALMETTO ALLIGATOR RESEARCH AND MANAGEMENT SYMPOSIUM ENJOYS STRONG FALL GATHERING AND CELEBRATES 90TH BIRTHDAY OF LOCAL ALLIGATOR LEGEND. After being held during the spring of 2016, 2017, 2019 and 2022, the 5th Palmetto Alligator Research and Management Symposium (PARMS) convened during late fall (9-10 November) of 2023. The meeting was again held at the Clemson University Baruch Institute of Coastal Ecology and Forest Science in Georgetown, South Carolina, and attracted approximately 85 people representing a diversity of stakeholder interests (eg state wildlife agencies, municipalities, private landowners, universities, animal parks, zoos and aquaria and NGOs). Originally intended to be a biennial event held on years opposite the Crocodile Specialist Group (CSG) Working Meetings, the PARMS schedule was disrupted by the COVID-19 pandemic (2020-2021). Holding meetings consecutively in 2022 and 2023 allowed attendees to share their work since the previous symposium (2019) while returning PARMS to the desired schedule. In addition, holding the meeting in November allowed us to recognize and celebrate the 90th birthday (14 November) of local alligator biologist and honorary CSG Steering Committee member, Phil Wilkinson.

In the afternoon of Day One (9 November), the meeting was kicked off with a captivating keynote presentation by Dr. Kent Vliet entitled "Four Decades of Mucking About with Alligators" in which Kent took the audience on a journey through his life as a crocodilian biologist and provided a behind-the-scenes look at many of the amazing projects and subsequent discoveries he has been a been a part of over the last 40 years. The keynote presentation was followed by a poster social where students, faculty, and other biologists shared their research and refreshments in a relaxed atmosphere (Figs. 1-2). Attendees then adjourned for dinner down on the Georgetown waterfront.

Figure 1. Attendees at 5th Palmetto Alligator Research and Management Symposium congregate during the poster social on 8 November 2023). Photograph: Thomas Rainwater.

Figure 2. From left; Jen Brueggen, Kent Vliet, Venetia Briggs-Gonzalez, Jeff Lang and Gretchen Lang following the keynote presentation on 9 November 2023. Photograph: John Brueggen.

On Day Two (10 November), 15 speakers from six states and two countries gave talks on crocodilian management and biology, with an emphasis on American alligator populations along both the US Atlantic and Gulf Coasts. These talks included reports on alligator management and associated issues in North Carolina, South Carolina, Georgia, Florida, Louisiana and Texas, as well as various aspects of alligator reproduction, movement, diet, aging, body condition, habitat use, occupancy/detection, population genetics, ecotoxicology, and rehabilitation from injury. Other presentations explored movement and management of American crocodiles in Florida and Costa Rica, and one talk reviewed the last 50 years of research conducted by The Croc Docs (University of Florida) on American crocodiles in the Florida Everglades. Dr. Jeff Lang made a return to PARMS and provided a thrilling update on the Gharial Ecology Project in India. At midday, the packed room of 80+ people surprised Phil Wilkinson with a rousing rendition of "Happy Birthday" to commemorate his 90th, just four days away. We also sang to Phil's long-time partner Libby Bernardin, whose birthday is the same day as Phil's (though she is younger).

Figure 3. From left; Chris Smaga, Ben Parrott and Jon Warner catch up during the symposium dinner on night of 10 November 2023. Photograph: Thomas Rainwater.

Figure 4. Pioneers in South Carolina alligator biology and management: Mark Bara and Phil Wilkinson at the symposium dinner. Photograph: Thomas Rainwater.

Figure 5. Celebrating Phil Wilkinson's 90th birthday at the symposium dinner. From left; Thomas Rainwater, Susan Woodward, Allan "Woody" Woodward, Phil Wilkinson, Libby Bernardin, Christy Wilkinson and two junior crocodilian biologists. Photograph: Miriam Boucher.

Following a second afternoon poster session, the meeting concluded with a dinner and social where speakers and attendees enjoyed the crisp fall weather, a roaring outdoor fire pit, and a traditional Lowcountry dinner of chicken bog (chicken, sausage, vegetables, spices, rice), she-crab soup, collard greens, and bleu-cheese coleslaw. The celebration of another successful meeting, birthdays, reunion of friends and colleagues, and the end of a scorching summer carried on deep into the night (Figs. 3-5).

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Recent Publications

Groh, S.S., Upchurch, P., Day, J.J. and Barrett, P.M. (2023). The biogeographic history of neosuchian crocodiles and the impact of saltwater tolerance variability. Royal Society Open Science 10: 230725.

Abstract: Extant neosuchian crocodiles are represented by only 24 taxa that are confined to the tropics and subtropics. However, at other intervals during their 200 Myr evolutionary history the clade reached considerably higher levels of species-richness, matched by more widespread distributions. Neosuchians have occupied numerous habitats and niches, ranging from dwarf riverine forms to large marine predators. Despite numerous previous studies, several unsolved questions remain with respect to their biogeographic history, including the geographical origins of major groups, eg Eusuchia and Neosuchia itself. We carried out the most comprehensive biogeographic analysis of Neosuchia to date, based on a multivariate K-means clustering approach followed by the application of two ancestral area estimation methods (BioGeoBEARS and Bayesian ancestral location estimation) applied to two recently published phylogenies. Our results place the origin of Neosuchia in northwestern Pangaea, with subsequent radiations into Gondwana. Eusuchia probably emerged in the European archipelago during the Late Jurassic/Early Cretaceous, followed by dispersals to the North American and Asian landmasses. We show that putative transoceanic dispersal events are statistically significantly less likely to happen in alligatoroids. This finding is consistent with the saltwater intolerant physiology of extant alligatoroids, bolstering inferences of such intolerance in their ancestral lineages.

Ugemuge, S.S., Badhawan, A.D., Gupta, P. and Vashistha, G. (2023). Cannibalism by a Mugger crocodile (*Crocodylus palustris*) in the Keterniaghat Wildlife Sanctuary, Uttar Pradesh, India. Reptiles & Amphibians 30: e20925.

Chanpradub, K., Pattanawibool, A., Saisamorn, A., Bhumpakphan, N., Chanthana, S., Thongsong, C., Ouansing, Y., Suksawate, W. and Sukmasuang, R. (2023). Abundance and habitat suitability of Siamese crocodiles (*Crocodylus siamensis*, Schneider 1801) in Phetchaburi River, Kaeng Krachan National Park, Thailand. Biodiversitas 24(9): 4755-4765.

Abstract: The Siamese crocodile (*Crocodylus siamensis*, Schneider 1801) is one of the critically endangered species with a remnant population reported in Kaeng Krachan National Park. This study aimed to investigate Siamese crocodiles' abundance and habitats along the Phetchaburi River. Thirteen rafting trips from December 2021 to July 2023 were conducted at a total distance of 315 km, recording 68 encounters with an encounter rate of 0.22 per km. It was estimated that the population size of Siamese crocodiles was four individuals. Environmental factors that influenced crocodile distribution, with slope, elevation, forest types, cumulative flow rates upstream, and land use patterns, were identified. These findings underscore the significance of the Phetchaburi River area for freshwater crocodile conservation, as indicated by a highly reliable model with a reliable score of 0.99 ± 0.02. Important recommendations include habitat protection, development of a crocodile threat surveillance system, ongoing population studies, and community involvement, which are essential for sustainable conservation practices, public awareness campaigns, captive breeding and reintroduction programs, and population restoration efforts. This research provides valuable insights into the habitats and environmental factors impacting Siamese crocodiles, highlighting the critical role of preserving Kaeng Krachan National Park as an important habitat for this species.

Chanpradub, K., Meunpong, P., Suksawate, W. and Sukmasuang, R. (2023). On the habitat of Siamese crocodiles (*Crocodylus siamensis*) in Phetchaburi River, Kaeng Krachan National Park, Phetchaburi Province, Western Thailand. Thai Journal of Forestry 42(2): 77-89.

Abstract: The freshwater crocodile or Siamese crocodile (Crocodylus siamensis) is a critically endangered species, with the Kaeng Krachan National Park playing a crucial role in its long-term conservation. This study aimed to investigate the habitat of Siamese crocodiles along the Phetchaburi River using direct observations, camera traps, and unmanned aerial vehicles. Over the course of nine rafting trips conducted between January and December 2022, covering a total distance of 315 km, which resulted in a recorded total of 68 encounters with the Siamese crocodiles or an encounter rate of 0.22 per km. The estimated population of Siamese crocodiles consisted of only four individuals. The study identified several environmental factors that influenced the crocodile distribution, with slope, elevation, forest type, cumulative upstream flow rate, and land use pattern ranked in order of importance. These findings underscore the significance of the Phetchaburi River area for the conservation of freshwater crocodile as indicated by a reliability score of 0.99 (SD= 0.02). To ensure the successful conservation of Siamese crocodiles, important recommendations include habitat protection. Additionally, the development of a crocodile threat surveillance system, ongoing population studies, and community involvement are essential for sustainable conservation practices, public awareness campaigns, captive breeding and reintroduction programs, and population restoration efforts. This research provides valuable insights into the habitats and environmental factors impacting the survival of freshwater crocodiles, highlighting the critical role of preserving Kaeng Krachan National Park as a sanctuary for this species.

Green, C. (2023). 'It's Very Spooky in Here': Young children's fears and anxieties in the natural environment. Early Child Development and Care (https://doi.org/10.1080/03004430.2023.2264529).

Abstract: Although nature is recognized as a setting that stimulates children's joy and wonder, few studies have examined the negative emotions that children experience in nature. This qualitative study explored 4-5-year-old Alaskan children's emotional, behavioural, and cognitive expressions of fear and anxiety during an outdoor excursion. Data was collected through sensory tours, in which children were equipped with wearable cameras while they explored. Findings revealed that half of the 20 children expressed fear and anxiety. Four themes (physical discomfort, trouble navigating, imagined danger, feeling scared and lost) characterized children's fearful encounters. Children created fearful situations by imaging

monsters, snakes, and alligators. Encountering dark and fallen limbs, navigating the tall grass and a slippery boardwalk provoked feeling lost and scared. Children self-regulated their fearful experiences through self-talk and staying close to one another. By paying attention to children's fearful emotions, adults can better support children's formative experiences in the natural world.

Weaver, K. (2023). Alligator skull. PANDION: The Osprey Journal of Research and Ideas 4(1): Article 14.

Abstract: Alligator Skull was created through mimicking the shadows on the bones of a giant creature with the dots of my pen. Living in Florida, I have known these animals my entire life, and I have been mesmerized by them the whole time. To see one humbled into a skeleton form is so intriguing. They are apex predators that encompass fear in many, but they are just as mortal as the rest of us. They only kill to survive, but the power they possess over the waters has humans either petrified or entranced. This individual from the *Alligator mississippiensis* species was only in its youth before death overcame its being. It was stripped from the muscle that could kill by something so gentle as degradation. I have always been an artist who has sought after realism. I want to encapsulate the exact beauty that I see on paper. I fought through this piece because the further you are from it, the more real it appears to be - as the dots blur together, yet a closer look reveals chaos. This is inevitable as it was created through the shadowing technique of stippling - an intriguing style made by strategically tapping a pen to paper at least hundreds of times. One tap seems to have done nothing, but a couple hundred brings back life to a skull. I am majoring in biology, with a concentration in coastal environmental science, and minoring in painting, drawing, and printmaking at the University of North Florida. Studying these subjects for years has brought me to a point where I adore scientific illustration. Combining the meditation and skill of art with the knowledge and curiosity of science makes creating these pieces a fascinating experience. When fabricating this piece, I did not stop at finding an aesthetic image, as my usual approach would suggest; instead, I researched the functions of the different bones and the reasons for the specks on the bones. I truly love illustrating in this way. This piece was only a start.

Zhang, H., Li, W., Tu, G., Sun, K., Yang, L., Wang, Z., Wu, Z., Zhou, Y., Zhang, S., Sun, H., Sheng, C., Wang, X., Zhang, R., Wu, X. and Pan, T. (2023). Host genetic background impacts microbiome composition in newborn alligator. Asian Herpetological Research 14(3): 237-245.

Abstract: Genetic factors play a key role in determination of the structure of the cloacal flora for newborn Chinese alligators. We collected the cloacal microbiomes for 24 newborn Chinese alligators from three different genetic backgrounds for 16S gene amplicon sequencing. The number of cloacal flora for the Chinese alligators from different groups was comparable but differed structurally. There were variations in proportions of floral compositions at the phylum and family levels; however, the main difference was at the genus level. There were two significant differences in richness and evenness among the three groups. Non-metric multidimensional scaling NMDS analysis revealed that the 24 samples could be clearly divided into three categories based on their genetic backgrounds (stress= 0.0244). Thus, we postulated that newborn Chinese alligators with different genetic backgrounds have different immune strengths, which affects individual responses to environmental microorganisms. In summary, newborn Chinese alligators from different genetic backgrounds exhibit variations in cloacal microbiome.

Thakur, A. (2023). Gait parameter tuning using Bayesian Optimisation for an alligator-inspired amphibious robot. Defence Science Journal 73(5): 519-530.

Abstract: This paper reports a sample-efficient Bayesian optimization approach for tuning the locomotion parameters of an in-house developed twelve degrees of freedom alligator-inspired amphibious robot. An optimization framework is used wherein the objective is to maximize the mean robot speed obtained via physical experiments performed on terrains with varying friction and inclinations and in the aquatic environment for swimming locomotion. We obtained an improvement in the mean robot speed by a factor of up to 6.38 using the developed approach over randomly generated locomotion parameters in 15 iterations.

Soni, A. (2023). Neurosensory Evolution in Thalattosuchians during their Land to Sea Transition. MSc thesis, Univsersity of Edinburgh, Edinburgh, Scotland.

Abstract: Thalattosuchia, a crocodylomorph clade, underwent a significant evolutionary transition from a semi-aquatic to a marine lifestyle. While skeletal adaptations during this transition are well-documented, endocranial changes have only recently been explored, with the neurosensory system remaining largely understudied. In this research, I delved into the variation and evolution of the neurosensory system within Thalattosuchia. Using μCT scans, I reconstructed the endocranial anatomy of nine thalattosuchian skulls, including two teleosaurids (*Mystriosaurus laurillardi* and *Plagiophthalmosuchus gracilirostris*), one metriorhynchoid (*Pelagosaurus typus*), and four derived metriorhynchids (*Cricosaurus araucanensis*, *Cricosaurus schroederi*, *Metriorhynchus brachyrhynchus*, and *Torvoneustes coryphaeus*). For a comprehensive comparison, endocranial reconstructions were also created for 12 extant crocodylians and two basal crocodylomorphs (*Protosuchus haughtoni* and *Eopneumatosuchus colberti*). Our findings revealed that certain features, such as the reduced sizes of the olfactory bulb and foramen magnum, had already evolved at the base of Thalattosuchia (teleosaurids). This was contrary to expectations that such features would be present in the more derived, pelagic thalattosuchians (metriorhynchids). Notably, in metriorhynchids, the jugular foramen enlarged, aligning with their shift towards hypercarnivory. However, these taxa displayed reduced sizes of the trigeminal ganglion, suggesting a reliance on other sensory organs. Species like *P. typus* emerges as a particularly enigmatic species, with unique neurosensory characteristics that underscore the importance of species-level examinations in understanding thalattosuchian evolutionary pathways. In essence, the neurosensory evolution of thalattosuchians paints a vivid picture of adaptations and anomalies. Our research provides significant insights into their transition to a pelagic lifestyle, it also highlights the avenues for future studies, especially for species with limited datasets.

Hoffbeck, C., Middleton, D.M.R.L., Nelson, N.J. and Taylor, M.W. (2023). 16S rRNA gene-based meta-analysis of the reptile gut microbiota reveals environmental effects, host influences and a limited core microbiota. Molecular Ecology (doi: 10.1111/mec.17153).

Abstract: An animal's gut microbiota plays an important role in host health, reproduction and digestion. However, many studies focus on only a few individuals or a single species, limiting our ability to recognize emergent patterns across a wider taxonomic grouping. Here, we compiled and reanalysed published 16S rRNA gene sequence data for 745 gut microbiota samples from 91 reptile species using a uniform bioinformatics pipe-line to draw broader conclusions about the taxonomy of the reptile gut microbiota and the forces shaping it. Our meta-analysis revealed the significant differences in alpha- and beta-diversity across host order, environment, diet, habitat and conservation status, with host diet and order contributing the most to these differences. We identified the principal bacterial phyla present in the reptile gut microbiota as Bacteroidota, Proteobacteria (mostly Gamma class), and Firmicutes, and detected the bacterial genus *Bacteroides* in most reptile individuals, thus representing a putative 'core' microbiota. Our study provides novel insights into key drivers

of the reptile gut microbiota, high-lights existing knowledge gaps and lays the groundwork for future research on these fascinating hosts and their associated microbes.

Rinehart, L.F., Lucas, S.G., Hunt, A.P. and Heckert, A.B. (2023). Skull and jaw shape as indicators of trophic guild association in temnospondyl amphibians and other predators. New Mexico Museum of Natural History and Science Bulletin 94: 585-609.

Abstract: We have investigated the skull morphology of numerous aquatic and semiaquatic predators, paying particular attention to the rostrum. Cluster analysis, using the ratios of a few skull or mandible measurements, shows that their skull shapes do not exist on a continuum that varies from relatively long to relatively short rostra and/or relatively narrow to relatively broad rostra. Rather, there are separate, distinct morphological clusters that represent various trophic guilds - groups with similar feeding habits. Three major guilds emerge from the analysis: ambush predators, generalists, and fish specialists. Similar analysis of mandible morphology also indicates clustering, but the guilds are not as well-defined and separated as in the skull data. The study specimens are dominated by metoposaurs, which are of principal interest, and other temnospondyls, as well as numerous other aquatic predators, including members of the Crocodylia, Phytosauridae, and a few salamanders and turtles for comparison. Results show that the brevirostral metoposaur-like amphibians form a guild of probable sit-and-wait ambush predators that may have also had active hunting capability. Suction feeders form a distinct group within the ambush predators, distinguished by extreme brevirostry. The generalist feeders comprise two overlapping guilds - one more alligator-like, such as *Mastodonsaurus*, *Sclerocephalus* and *Eryops*, and another more crocodile-like, including the robust phytosaurs and the long-snouted temnospondyls, *Eocyclotosaurus*, and *Wellesaurus*. A third distinct guild comprises the fish-specialists, including the gracile phytosaurs and the gharial-like crocodylids that possess long, tubular rostra. We found that there is a high degree of individual variation in skull shapes of the Metoposauridae and some other taxa. These individual shape variations often outweigh specific or generic morphological differences. Although the metoposaur-like amphibians have often been judged to fill an alligator-like feeding niche or to be suction feeders, our analysis shows that their skull morphology and presumably their feeding method is quite distinct from the Alligatoridae, and they are also morphologically distant from the suction feeders and other predatory temnospondyls. We establish the boundaries of these morphological clusters so this simple morphometric method may be used as a diagnostic tool to help categorize the feeding habits of fossil species.

Zhu, Y., Li, Y., Pan, T., Li, En. and Wu, X. (2023). Candidate regulatory genes for hindlimb development in the embryos of the Chinese alligator (*Alligator sinensis*). Animals 13: 3126.

Abstract: Crocodilians, which are a kind of animal secondary adaptation to an aquatic environment, their hindlimb can provide the power needed to engage in various life activities, even in low-oxygen water environments. The development of limbs is an important aspect of animal growth and development, as it is closely linked to body movement, support, heat production, and other critical functions. For the Chinese alligator, the hindlimb is one of the main sources of power, and its development and differentiation will directly influence the survival ability in the wild. Furthermore, a better understanding of the hindlimb developmental process will provide data support for the comparative evolutionary and functional genomics of crocodilians. In this study, the expression levels of genes related to hindlimb development in the Chinese alligator embryos during fetal development (on days 29, 35, 41, and 46) were investigated through transcriptome analysis. A total of 1675 differentially expressed genes (DEGs) at different stages were identified by using limma software. These DEGs were then analyzed using weighted correlation network analysis (WGCNA), and 4 gene expression modules and 20 hub genes were identified that were associated with the development of hindlimbs in the Chinese alligator at different periods. The results of GO enrichment and hub gene expression showed that the hindlimb development of the Chinese alligator embryos involves the development of the embryonic structure, nervous system, and hindlimb muscle in the early stage (H29) and the development of metabolic capacity occurs in the later stage (H46). Additionally, the enrichment results showed that the AMPK signaling pathway, calcium signaling pathway, HIF-1 signaling pathway, and neuroactive ligand-receptor interaction are involved in the development of the hindlimb of the Chinese alligator. Among these, the HIF-1 signaling pathway and neuroactive ligand-receptor interaction may be related to the adaptation of Chinese alligators to low-oxygen environments. Additionally, five DEGs (CAV1, IRS2, LDHA, LDB3, and MYL3) were randomly selected for qRT-PCR to verify the transcriptome results. It is expected that further research on these genes will help us to better understand the process of embryonic hindlimb development in the Chinese alligator.

Lemaire, J. (2023). Using crocodylians for monitoring mercury in the tropics. Ecotoxicology (doi: 10.1007/s10646-023-02703-1).

Abstract: Mercury contamination is a widespread phenomenon that impacts ecosystems worldwide. Artisanal Small Scale Gold Mining (ASGM) activities are responsible for more than a third of atmospheric Hg emission. Due to Hg toxicity and its broad and elevated prevalence in the environment resulting from ASGM activities in the tropics, its biomonitoring is essential to better understand the availability of its methylmercury (MeHg) form in the environment. The Minamata Convention was ratified with the objective to “protect human health and the environment from anthropogenic emissions and releases of mercury compounds”. Biomagnification of MeHg occurs through the trophic food web, where it biomagnifies and bioaccumulates in top predators. To monitor environmental MeHg contamination, studies have evaluated the use of living organisms; however, reptiles are among the least documented vertebrates regarding MeHg exposure. In this review we evaluate the use of crocodylians for Hg biomonitoring in tropical ecosystems. We found that out of the 28 crocodiles species, only 10 have been evaluated regarding Hg contamination. The remaining challenges when using this taxon for Hg biomonitoring are inconsistencies in the applied methodology (eg wet versus dry weight, tissues used, quantification method). However, due to their life history traits, crocodylians are particularly relevant for monitoring MeHg contamination in regions where ASGM activities occur. In conclusion and given their ecological and socio-economic importance, crocodylians are at great risk of MeHg contamination and are excellent bioindicators for tropical ecosystems.

Pees, M., Brockmann, M., Steiner, N. and Marschang, R.E. (2023). *Salmonella* in reptiles: a review of occurrence, interactions, shedding and risk factors for human infections. Frontiers in Cellular and Developmental Biology (doi: 10.3389/fcell.2023.1251036).

Abstract: *Salmonella* are considered a part of the normal reptile gut microbiota, but have also been associated with disease in reptiles. Reptile-associated salmonellosis (RAS) can pose a serious health threat to humans, especially children, and an estimated 6% of human sporadic salmonellosis cases have been attributed to direct or indirect contact with reptiles, although the exact number is not known. Two literature searches were conducted for this review. The first evaluated reports of the prevalence of *Salmonella* in the intestinal tracts of healthy reptiles. *Salmonella* were most commonly detected in snakes (56.0% overall), followed by lizards (36.9%) and tortoises (34.2%), with lower detection rates reported for turtles (18.6%) and crocodilians (9%). Reptiles in captivity were significantly more likely to shed *Salmonella* than those sampled in the wild. The majority of *Salmonella* strains described in reptiles belonged to subspecies I (70.3%), followed by subspecies IIIb (29.7%) and subspecies II (19.6%). The second literature search

focused on reports of RAS, revealing that the highest number of cases was associated with contact with turtles (35.3%), followed by lizards (27.1%) and snakes (20.0%). Reptiles associated with RAS therefore did not directly reflect prevalence of *Salmonella* reported in healthy representatives of a given reptile group. Clinical symptoms associated with RAS predominantly involved the gastrointestinal tract, but also included fever, central nervous symptoms, problems with circulation, respiratory symptoms and others. Disease caused by *Salmonella* in reptiles appears to be dependent on additional factors, including stress, inadequate husbandry and hygiene, and other infectious agents. While it has been suggested that reptile serovars may cause more severe disease than human-derived strains, and some data is available on invasiveness of individual strains in cell culture, limited information is available on potential mechanisms influencing invasiveness and immune evasion in reptiles and in RAS. Strategies to mitigate the spread of *Salmonella* through reptiles and to reduce RAS focus mostly on education and hygiene, and have often been met with some success, but additional efforts are needed. Many aspects regarding *Salmonella* in reptiles remain poorly understood, including the mechanisms by which *Salmonella* persist in reptile hosts without causing disease.

Sambou, O., Marjono, Ciptadi, G. and Putra, F. (2023). Impacts of COVID-19 on ecotourism: A study in Bijilo Monkey Forest and Kachikally Crocodile Pool, The Gambia. Journal of Indonesian Tourism and Development Studies 11(2): 65-70.

Abstract: Most people agree that COVID-19 has affected the tourism sector the most. This paper seeks to find the socioeconomic impacts of COVID-19 on the destination under study. The research implored semi-structured interviews, observations, and content analysis to acquire information. The first case of the virus in The Gambia was registered on the 16 March 2020. As of the 29 January 2021, the country registered 4090 positive cases of COVID-19, out of whom 3792 have recovered, 128 are confirmed to have died, and 170 active cases. A total of 59% of confirmed cases are male and 41% female. The ecotourism industry of The Gambia is hit hard by the impacts of COVID-19. The places highly affected are the wildlife ecologies with no spiritual connections. There is evidence of wildlife crime and negative human-wildlife interaction. Sacred sites are easier to manage as people's spirituality frowns at wildlife cruelty. The pandemic has caused severe economic, health, and social challenges in the Gambia, killing many and disrupting the normal functioning of society, including wildlife ecologies in some places. It has increased wildlife hunger in Kachikally Crocodile Pool, economic distress, and human-wildlife conflict in Bijilo Monkey Forest and surrounding.

Moss, R.A., Murphy, K.M., Gardner, S.T., Watkins, M.M., Finger Jr, J.W., Kelley, M.D., Elsey, R.M., Warner, D.A. and Mendonça, M.T. (2023). Exposure to ecologically relevant estrogen levels do not influence morphology or immune parameters in hatchling American alligators (*Alligator mississippiensis*). Comparative Biochemistry and Physiology C. Toxicology and Pharmacology (doi: 10.1016/j.cbpc.2023.109767).

Abstract: Human activity has increased concentrations of endocrine-disrupting contaminants (EDCs) in many ecological systems. Many EDCs are xenoestrogens, which imitate naturally derived estrogen like estradiol 17-β (E2). These pollutants can critically affect a broad range of biological functions, particularly in organisms inhabiting aquatic environments. E2 and associated receptors are involved in regulating innate immune responses, where documentation of exogenous E2 on immune parameters is important for understanding health consequences. In this study, we explore the impact of environmentally relevant concentrations of E2 on circulating glucocorticoid levels and several innate immune parameters in hatchling American alligators (*Alligator mississippiensis*). Twenty-three hatchling alligators were randomly placed in one of three groups that differed in dietary E2 concentration: control (no E2 exposure), low E2 (0.5 μg/kg E2), or high E2 (1 μg/kg E2) for 10 weeks. Following this period, several biomarkers were quantified to monitor the impact of E2: growth, change in body condition, white blood cell (WBC) counts, glucocorticoid levels, and general antibody response. Blood E2 concentrations were greater in individuals exposed to E2, but plasma corticosterone levels were reduced among the experimental groups. Morphology, growth, and immune parameters of E2 exposed animals did not differ from controls. These results suggest that acute exposure to increased environmental estrogen concentrations may alter plasma hormone concentrations but have little to no impact on morphology or immune responses. Future studies may expand on this by monitoring biomarkers in wild populations across time, which will provide insight into how different species are impacted by environmental contaminants.

Petano-Duque, J.M., Rueda-García, V. and Rondón-Barragán, I.S. (2023). Virulence genes identification in *Salmonella enterica* isolates from humans, crocodiles, and poultry farms from two regions in Colombia. Veterinary World 16(10): 2096-2103.

Abstract: *Salmonella* spp. is frequently found in the digestive tract of birds and reptiles and transmitted to humans through food. Salmonellosis is a public health problem because of pathogenicity variability in strains for virulence factors. This study aimed to identify the virulence genes in *Salmonella* isolates from humans, crocodiles, broiler cloacas, and broiler carcasses from two departments of Colombia. This study was conducted on 31 *Salmonella enterica* strains from humans with gastroenteritis (7), crocodiles (7), broiler cloacas (6), and broiler carcasses (12) from Tolima and Santander departments of Colombia, belonging to 21 serotypes. All samples were tested for *Salmonella* spp. using culture method on selective and non-selective mediums. Extraction of genomic DNA was performed from fresh colonies, DNA quality was verified by spectrophotometry and confirmed by amplification of InvA gene using conventional polymerase chain reaction (PCR). bapA, fimA, icmF, IroB, marT, mgtC, nlpI, oafA, pagN, siiD, spvC, spvR, spvB, Stn, and vexA genes were amplified by PCR. The most prevalent gene was bapA (100%), followed by marT (96.77%), mgtC (93.55%), and fimA (83.87%). Likewise, IroB (70.97%), Stn (67.74%), spvR (61.29%), pagN (54.84%), icmF (54.8%), and SiiD (45.16%) were positive for more than 50% of the strains. Furthermore, none of the isolates tested positive for the vexA gene. *Salmonella* isolates presented 26 virulence profiles. This study reported 14 virulence genes in *Salmonella* spp. isolates from humans with gastroenteritis, crocodiles, and broiler cloacas and carcasses. The distribution of virulence genes differed among sources. This study could help in decision-making by health and sanitary authorities.

Johnson, M.M., Amson, E. and Maxwell, E.E. (2023). Evaluating growth in *Macrospondylus bollensis* (Crocodylomorpha, Teleosauroidea) in the Toarcian Posidonia Shale, Germany. Papers in Palaeontology 2023: e1529.

Abstract: The study of how organisms grow is a fundamental aspect of palaeontology. Growth in teleosauroids is poorly understood and little studied, especially in an ontogenetic sense. We investigate growth rates of the most common and abundant teleosauroid, *Macrospondylus bollensis*, in which a large sample of multiple body sizes is available from the Posidonienschiefer Formation (Posidonia Shale) of southwestern Germany. We perform linear regression analyses on 62 specimens of *Macrospondylus* (16 juveniles, 7 subadults and 39 adults) using 21 cranial and postcranial measurements. Our results show that juvenile, subadult andadult individuals have near-isometric or isometric growth throughout much of the body. Notably, we find that in *Macrospondylus*: (1) the femur grows at a faster rate than the skull and hindlimb zeugopodium; (2) the forelimb and hindlimb grow at the same rate; and (3) there is distinct ontogenetic signal in the growth of the orbit and supratemporal fenestra. We also find that limb scaling

in *Macrospondylus* somewhat comparable to that seen in the extant gavialids *Gavialis gangeticus* and *Tomistoma schlegelii*. Last, we examine evolutionary allometry in skull length relative to body size in Crocodylomorpha using femoral length as a proxy, which shows a near-isometric trend. Non-thalattosuchian crocodylomorphs (with the exception of one pholidosaurid and one dryosaurid taxon) are differentiated from thalattosuchians due to their shorter skulls, as previously suggested, but the scaling relationship with femur length remains unchanged.

Wilson, O.E. and Parker, A.K. (2023). Low predator competition indicates occupation of macro-predatory niches by giant Miocene reptiles at La Venta, Colombia. Palaeogeography, Palaeoclimatology, Palaeoecology (https://doi.org/10.1016/j.palaeo.2023.111843).

Abstract: The La Venta fauna of Colombia (~13.5-11.5 Ma) represents the most diverse Tertiary locality in the neotropics, with 75 mammal species and a highly non-analogue reptile assemblage containing at least seven testudines and six crocodyliforms. It has been widely hypothesized that the carnivore guilds of South American mammals throughout the Cenozoic were depauperate, potentially due to the continent's isolated history, and that, as a result, non-mammals acted as its dominant predators. Here we test this hypothesis using novel community composition analysis and a model of prey meat availability and competition between carnivorous taxa for prey in different size classes. We find that the carnivorous reptiles account for a very large proportion of demanded biomass, but that, even including reptiles, there was minimal competition for resources among the carnivore guild, relative to competition within modern communities. Further, we evaluate one possible impact of low predation pressure on the herbivores of La Venta through a population analysis of enamel hypoplasia in the notoungulate *Pericotoxodon platignathus*. At La Venta, mammalian carnivores alone exerted very little predation pressure on the terrestrial community, and our community composition analysis supports the filling of macropredatory niches by crocodyliforms, including both the terrestrial sebecid *Langstonia huilensis* and semi-aquatic giant crocodylians.

Halm, D.T. (2023). Applied Animal Ethics in Captivity and Conservation Science. PhD thesis, The University of Utah, Salt Lake City, Utah, USA.

Abstract: Ethical discussion about animals often considers obligations in the abstract, but there is emerging literature about applied ethical cases and how to think about underphilosophized cases. This dissertation contributes to this by discussing three specific ethical cases involving animals. First, I critique the science and ethics of animal shelter behavior assessments. Following that, I show how viewing animals as property, a common feature of American wildlife management, leads to predictable ethical failures. Finally, I analyze the keystone species concept and argue why it applies to unusual cases, such as Burmese pythons, and why it is a flawed concept to guide conservation actions. Along with the philosophical discussion, this dissertation creates tools to facilitate more scientifically and ethically sophisticated policies that affect animals, at institutions like wildlife management agencies and humane societies, to address philosophical issues at the science-policy interface.

Sears, T. (2023). Decolonizing crocodiles, repatriating birds. Human-animal relations in the Indian landscape. *In* The Routledge Companion to Decolonizing Art History. Routledge: Oxfordshire. 13pp.

Abstract: This chapter thinks through decolonization in the context of human-animal relations in the Indian subcontinent. It looks to precolonial sources to engage both the ongoing effects of colonial-era policies and the failure of conservation in the postcolonial nation.

Kojima, L.V., Kohl, M.T., Rainwater, T.R., Parrott, B.B. and Tuberville, T.D. (2023). Environmental contaminant bioaccumulation and movement behavior of a long-lived apex predator. Available at SSRN: https://ssrn.com/abstract=4604301 or http://dx.doi.org/10.2139/ssrn.4604301.

Abstract: Animal movement behavior provides insight into organismal and ecological function. These functions are often disturbed by anthropogenic influences, such as urbanization and habitat fragmentation, yet the effects of long-term exposures to environmental contaminants on movement have yet to be examined. The long lifespans and broad diets of crocodilians often lead to bioaccumulation of persistent contaminants and confer a marked vulnerability to consequent physiological effects resulting from elevated contaminant body burdens. In this study, we investigate the relationships between blood concentrations of mercury (Hg), a widespread contaminant with well characterized neurotoxicity, and movement patterns in free living, naturally exposed American alligators (*Alligator mississippiensis*). We sampled adult male alligators from two former nuclear cooling reservoirs with different Hg contamination histories and placed GPS transmitters on a subset of individuals from each reservoir (13 total). Data collected over the ensuing two years were analyzed using a linear mixed effects framework combined with AICc model selection to resolve the relationships linking seasonal alligator movement (daily activity (seconds) and daily distance (metres)) and home range to climate conditions, individual traits, and blood Hg concentrations (mg/kg; wet weight). We found that climate conditions, alligator size (snout-vent length), and Hg blood concentrations all influence alligator daily activity, but do not contribute to alligator daily movement (distance). Furthermore, we found that Hg blood concentrations were strongly correlated with seasonal home range size where individuals with elevated Hg had larger home ranges in spring, fall, and winter. These findings provide insight into how climate, anthropogenic contaminants, and individual traits relate to alligator movement patterns resolved across seasonal scales.

De Araujo Sena, M.V., Montefeltro, F.C., Marinho, T.S., Langer, M.C., Fachini, T.S., Piacentini Pinheiro, A.E., Machado, A.S., Lopes, R.T., Pellarin, R., Sayao, J.M., Oliveira, G.R. and Cubo, J. (2023). The cost of living in Notosuchia (Crocodyliformes, Mesoeucrocodylia). Palaeogeography, Palaeoclimatology, Palaeoecology (https://doi.org/10.1016/j.palaeo.2023.111855).

Abstract: Limbs of terrestrial notosuchian crocodyliforms are characterized by a permanent parasagittal position that approaches that of mammals and dinosaurs. Thus, we expect high maximal rates of oxygen consumption (ie high aerobic capacities). To test this hypothesis, we inferred mass-independent maximal metabolic rates (MMR) in 7 notosuchian species using the femur blood flow rate ($\dot{Q}$; $cm^3\ s^{-}$) correlated with the maximal metabolic rate as a proxy. We employed a phylogenetic eigenvector maps (PEMs) inference model based on 20 extant tetrapod species. Generally, ectothermic amniotes have lower maximal metabolic rates than similarly sized endotherms. However, certain anatomical features of the cardiorespiratory system in varanid lizards enable them to develop a more active lifestyle than other ectothermic sauropsids. We found that the retrodicted mass-independent aerobic capacity values for Notosuchia are lower than those measured in mammals. These values are higher than those quantified in extant Crocodylia, but lower than values measured in extant lizards. Notosuchians exhibit $\dot{Q}$ values on the femoral shaft higher than *Crocodylus porosus*, suggesting greater oxygen consumption during intense exercise, but significantly lower than those measured in varanid lizards. This condition probably allowed notosuchians to engage in prolonged strenuous locomotion activities, such as hunting prey, defending themselves from predators or avoiding competitors. The evolution of Mesoeucrocodylia metabolism involves at least two phenotypes, a relatively high (Notosuchia) and a low (Neosuchia, Crocodylia) MMR.

Bels, V., Le Floch, G., Kirchhoff, F., Gastebois, G., Davenport, J. and Baguette, M. (2023). Food transport in Reptilia: a comparative viewpoint. Philosophical Transactions of the Royal Society B Volume 378(1891) (https://doi.org/10.1098/rstb.2022.0542).

Abstract: Reptilia exploit a large diversity of food resources from plant materials to living mobile prey. They are among the first tetrapods that needed to drink to maintain their water homeostasis. Here were compare the feeding and drinking mechanisms in Reptilia through an empirical approach based on the available data to open perspectives in our understanding of the evolution of the various mechanisms determined in these Tetrapoda for exploiting solid and liquid food resources.

Dinets, V. (2023). Play behavior in ectothermic vertebrates. Neuroscience & Biobehavioral Reviews (doi: 10.1016/j.neubiorev.2023.105428).

Abstract: Until a few decades ago, play was considered a behavior unique to birds and mammals. Although play in other vertebrates is still a neglected research subject, data on it has been slowly accumulating, and is reviewed here. Now we know that animals as diverse as stingrays, cichlid fishes, monitor lizards, softshell turtles, and crocodiles can be unexpectedly playful. This knowledge has implications to broader theoretical problems, but much more research attention is needed to utilize its potential.

Ruslan, N.A., Madin, J. and Saimin, S. (2023). Trends of attacks on humans by protected crocodiles along rivers and associated habitats in Borneo Island. Journal of Tropical Biology and Conservation 20: 1-26.

Abstract: In the human-crocodile conflict, crocodile attacks on humans pose a serious threat and are becoming a complex conservation challenge in many countries. This study investigates the status and trend of crocodile attacks on humans in Malaysian Borneo (ie Sabah and Sarawak) where rivers and estuaries are inhabited by protected crocodile populations. Results show that between 2001 and 2020, a total of 205 attacks were reported which equals an average of nearly 11 cases per year. The number of attacks in Sarawak is estimated to be between 135 to 164 cases which is twice ($p<0.05$) as high as in Sabah (70 cases), indicating a more serious human-crocodile conflict in the former. In Sabah, most of the attacks (81% or 57 cases) ($p<0.05$) were in the districts of Lahad Datu, Kinabatangan, Tawau and Sandakan while in Sarawak (82% or 60 cases) ($p<0.05$) were in Miri, Sri Aman, Kuching and Betong. Almost 80% (173 cases) of the victims were men between the ages of 30 and 39 who were fishing (42%) ($p<0.05$) or bathing (27%) before the attack suggesting that such activities are risky and should be avoided in areas inhabited by crocodiles. Fatality rates of crocodile attacks have been increasing in recent years (ie 2015-2020) with an average of 10 cases per year. Therefore, control over the number of crocodile populations, especially the large-sized and dangerous individuals, needs to be implemented in high-risk areas. More research is needed to understand the capacity of their habitats to support optimal populations density and minimize conflicts with humans.

Coradini, M.F., Oliveira, G.G., Sbaraini, S.C., Almeida, F.L.A. de and Souza, M.L.R. de (2023). Temperature, pH and sarcomere length of *Caiman yacare* in different body weight categories at slaughter. Revista Brasileira de Saúde e Produção Animal, Salvador 23 (http://dx.doi.org/10.1590/S1519-99402020232012).

Abstract: The objective of this work was to characterize the internal temperature of the carcass, pH and sarcomere length in four categories of body weight at a slaughter. The categories were: category 1, animals up to 1.5 kg, category 2, animals from 1.501 to 2.5 kg, category 3, animals from 2.501 to 3.5 kg and category 4, animals over 3.501 kg. The time intervals evaluated were 0.5, 2, 4, 6, 8, 10, 12, 14, 16, 18, 24 and 36 hours after bleeding, therefore, a factorial scheme (4 x 12) was used, in which where four categories of pre-slaughter weight and the behavior of the carcasses during the post-slaughter time were evaluated. There was no interaction effect between the weight categories and the time for the variation of the carcass internal temperature, pH and sarcomere length, but when only the time of rigor was evaluated, there were significant differences for the analyzed parameters. The internal temperature of the initial average carcass (0.5 hours) was 16.02°C, reaching 3.80°C at 36 hours post-slaughter. In addition, the lowest average pH found was at 24 hours, with a value of 5.39. Regarding the sarcomere length, the smallest mean length observed was 1.41 μm at 16 hours post-slaughter and the final mean length (36 hours) was 1.89 μm. It was concluded that the analyzed margin of the categories of body weight at slaughter did not interfere in the variation of temperature, pH and sarcomere length during the post-mortem of the Pantanal caiman.

Mascarenhas-Junior, P.B., Strickland, B.A., Heithaus, M.R., Simõe, P.I. and Correia, J.M.S. (2023). Factors inuencing detection, distribution and population dynamics of the broad-snouted caiman (*Caiman latirostris*) in an altered environment in north-eastern Brazil. Research Square (doi: https://doi.org/10.21203/rs.3.rs-3452654/v1).

Abstract: Nocturnal spotlight surveys have been historically used to determine patterns in crocodylians' space-time ecology. This approach provides reliable insights about their conservation, especially when is based on long-term monitoring. We assessed how weather, habitat features, and anthropogenic factors inuence distribution and population trends of broad-snouted caiman (*Caiman latirostris*) in an altered Atlantic Forest habitat in north-eastern Brazil. From 2015 to 2022, we conducted night counts to detect caimans, measure several abiotic variables and assess human activity. To account for changes in encounter rates based on abiotic variables, we employed a Generalized Linear Modeling approach and a single-species occupancy model to predict caiman probability of occurrence within the reservoir. Average caiman encounter rate in the reservoir was 1.3 ind/km, consistent with estimates conducted in other locations in Brazil. The population size remained stable over the study period, although adults encounter rates increased. Water temperature and humidity positively affected caiman detection, whereas rainfall and cloud coverage had a negative inuence on counts, likely due to their impacts on caiman metabolism and foraging behavior. Caimans were distributed throughout the reservoir, with a preference for the river channel and forested sectors, which offered protection from humans and possibly provided greater resources availability. The presence of gillnets was positively correlated with caiman distribution, explained by caimans opportunistically feeding on tangled fish. Our findings comprise the first long-term study of a broad-snouted caiman population dynamics in Brazil and provide useful guidelines for determining priority areas for caiman conservation within the highly threatened Atlantic Forest biome.

Mori, K.Y., Keuroghlian-Eaton, S., Cavalheri, D.G., de Almeida-Júnior, J.E., Müller, M.M.P. and Santana, D.J. (2023). Predation attempt on *Trachycephalus typhonius* (Linnaeus, 1758) by *Caiman yacare* (Daudin, 1802). Herpetology Notes 16: 745-747.

Griffiths, K.R., McLaughlin, J.L.H., Hall, F., Partis, L., Hansen, S.C., Tulloch, R. and Burke, D.G. (2023). Development of seven new dPCR animal species assays and a reference material to support quantitative ratio measurements of food and feed products. Foods 12: 3839.

Abstract: Laboratory testing methods to confirm the identity of meat products and eliminate food fraud regularly rely on PCR amplification of extracted DNA, with most published assays detecting mitochondrial sequences, providing sensitive presence/

absence results. By targeting single-copy nuclear targets instead, relative quantification measurements are achievable, providing additional information on the proportions of meat species detected. In this Methods paper, new assays for horse, donkey, duck, kangaroo, camel, water buffalo and crocodile have been developed to expand the range of species that can be quantified, and a previously published reference assay targeting the myostatin gene has been modified to include marsupials and reptiles. The accuracy of this ratio measurement approach was demonstrated using dPCR with mixtures of meat DNA down to 0.1%. However, the limit of detection (LOD) of this approach is not just determined by the assay targets, but by the samples themselves, with food or feed ingredients and processing impacting the DNA yield and integrity. In routine testing settings, the myostatin assay can provide multiple quality control roles, including monitoring the yield and purity of extracted DNA, identifying the presence of additional meats not detected by the suite of species-specific assays and potentially estimating a sample-specific LOD based on measured copy numbers of the myostatin target. In addition to the myostatin positive control assay, a synthetic DNA reference material (RM) has been designed, containing PCR targets for beef, pork, sheep, chicken, goat, kangaroo, horse, water buffalo and myostatin, to be used as a positive template control. The availability of standardised measurement methods and associated RMs significantly improves the reliability, comparability and transparency of laboratory testing, leading to greater confidence in results.

Varsha, V. (2023). Sustainability Assessment and Challenges of Tourism Development in Andaman and Nicobar Islands: A Case Study of Mahatma Gandhi Marine National Park (MGMNP) and Wandoor Beach. MSc thesis, Norwegian University of Life Sciences Norway.

Abstract: Tourism has become a significant source of income for the Andaman and Nicobar Islands, leading to a notable rise in local involvement in tourism-related endeavors. This transition from traditional livelihoods has led to an increased reliance of the local population on tourism as their primary economic activity. However, this shift has also made them more susceptible to the potential vulnerabilities that the tourism sector can introduce. In this research, we conducted an analysis of the sustainability of tourism in light of the challenges encountered by the sector, using the Mahatma Gandhi Marine National Park and Wandoor Beach as a case study. The findings underscore both the emergence of tourism as a means of livelihood and its associated vulnerabilities for the host communities, highlighted by consecutive incidents of crocodile attacks and the subsequent closure due to the COVID-19 pandemic.

Mubarak, F.S. and Kanagaratnam, K. (2023). Placing locking compression plates as an external fixator in wild animal (crocodile) bite victim: A case report. Cureus 15(10): e47511.

Abstract: Animal bites can cause severely contaminated open fractures, especially in the hand, wrist, and lower extremities, requiring expert orthopedic care. This case report emphasizes the unique issues posed by such injuries, particularly in low-income areas with limited access to comprehensive medical services. Pediatric examples, such as open tibiofibular fractures caused by animal encounters, highlight the significance of individualized treatment techniques. Crocodile bites, though infrequent, present an extreme peril and potential fatality. In Sri Lanka, where various crocodile species inhabit the waters, such incidents are rare but present. Long bone fractures caused by crocodile bites are significant and complicated injuries. The enormous force of a crocodile's jaw can cause substantial damage to bones, tendons, and surrounding tissues, often resulting in significant bone and soft tissue loss. Managing such injuries is extremely difficult, especially in low-resource settings. The use of a locking plate as an external fixator is a novel approach in the treatment of open fractures, nonunion, septic arthritis, and even as a distraction osteogenesis adjuvant. While it is not as common in typical fracture fixation textbooks, it is critical in specialized instances. This study describes a unique case of a 13-year-old boy with a Gustilo-Anderson Type IIIA crocodile bite who was treated in a low-income environment with a locking plate as an external fixator.

Mursyid, A.M., Faradiba, F. and Najib, A. (2023). Peel off mask formulation of crocodile oil (*Oleum crocodylus porosus*). Abstract, 2nd Makassar International Conference on Pharmaceutical Sciences 2(1): 43. Universitas Muslim Malaysia.

Abstract: Estuary crocodile oil provides antimicrobial activity against *Streptococcus epidermidis* bacteria which can cause acne. This research aims to produce a pharmaceutically stable peel off mask preparation. Mask preparations are made with variations of 10% and 12% PVA base; CMC 1% and 2%. Stability tests were carried out using the forced condition technique at temperatures of 5°C and 35°C for 12 hours each for 10 cycles. Evaluation of pharmaceutical properties includes organoleptic examination, homogeneity, drying time, spreadability, pH, viscosity and flow type. The evaluation results after forced conditions in the organoleptic test on all formulas were white with a thick consistency and a distinctive odor . In the homogeneity test, all formulas had good homogeneity. The results of the 10% PVA spreadability test= 6.7; PVA 12%= 6.0; CMC 1%= 7.8 and CMC 2%= 5.7. The results of measuring the pH of PVA 10%= 8.0; PVA 12%= 8.0; CMC 1%= 7.9 and CMC 2%= 8.0. Viscosity value (Poise) PVA 10%= 16.07; PVA 12%= 26.93; CMC 1%= 58.1 and CMC 2%= 66.93. Overall, the tests met the requirements of pharmaceuticals and after the conditions were forced, there were no significant changes. It can be concluded that crocodile oil can be formulated into a peel-off mask that meets pharmaceutical requirements.

Villegas, A., Flores-Martínez, J.J., de Mayo Mejenes-López, S. and Babb-Stanley, K.A. (2023). Population dynamics of Morelet's crocodile (*Crocodylus moreletii*) using data of national monitoring in Mexico. Studies on Neotropical Fauna and Environment (https://doi.org/10.1080/01650521.2023.2266191).

Abstract: Morelet's crocodile populations have limited distribution along the coast of Mexico, Belize, and Guatemala, and have been greatly affected by human activities. Morelet's crocodile is a species with high ecological and economic value. From an ecological perspective, it is an apex predator in the ecosystems in which it lives. Because of their vulnerable status is essential to have updated information on its populations over time to know their current conservation status. We analyze with a population model the vital rates of importance for the management and conservation of this species. Population growth with the Nocturnal Visual Detection model showed growth ($\lambda = 1.027$) over a 100 years, as in modeling Marking and Recapture of Specimens model ($\lambda = 1.026$). The largest reproductive value (v) was observed in the Adult stage (0.458). The sensitivity matrix indicated that the most sensitivity was offspring production by Adults (5.59). The data presented here show that the main factors impacting adult survival and the transition from Subadult to Adult stages alter population growth. Using the results of this model to quantitatively compare the conservation strategy can prove extremely useful to discern the parameters that must be taken into consideration and their potential effect on the population.

Marín-Enríquez, E., Charruau, P. and Félix-Salazar, L.A. (2023). Discovery of a suburban wetland refuge for a depleted American crocodile (*Crocodylus acutus*) population in northwestern Mexico, using a commercial Unmanned Aerial Vehicle. Tropical Conservation Science 6 (https://doi.org/10.1177/194008292312098).

Abstract: The Urías Coastal Lagoon (UCL) is a heavily modified and polluted lagoon near Mazatlán, in northwestern Mexico. Once abundant in the UCL, the American crocodile (*Crocodylus acutus*) is

now rarely seen in the area. A healthy population of apex predators is essential to maintain the trophic balance of ecosystems. Our research aim was to lay the groundwork for studies of American crocodile population ecology in the UCL. Traditional boat surveys (day and night) of crocodiles were undertaken in the UCL in May-July 2022. Two exploratory aerial (~30 m altitude) surveys of a small wetland located close to a habitational complex in the vicinity of the UCL were performed in June and December 2022, using a commercial Unmanned Aerial Vehicle (UAV). We used images obtained with the UAV to estimate the size of the crocodiles detected in the wetland. This study confirms the presence of American crocodiles in the UCL and presents the first information on individuals of this species for this area. Aerial surveys revealed the presence of 17 individuals in the wetland; the mean size of nine of those individuals was 183.3 ± 60 cm (range: 130-310 cm). Two yearlings (~37 cm length), possibly born in June 2022, were captured in the same wetland in September 2022. We also surveyed 50.7 km of UCL coastline by boat, but no crocodiles were sighted. The crocodiles seem to avoid the human-impacted UCL and likely use the less impacted surrounding wetlands as a refuge area, which they also use to reproduce. The presence of both yearlings and adults is a good sign for the survival of this vulnerable population. We believe that the surveyed wetland should be closely monitored for conservation purposes because it might be one of the last crocodile breeding refuges in the heavily modified and polluted coastal environment of the UCL. We summarize our results with a series of recommendations for local and federal authorities. These recommendations would likely help the conservation of the American crocodile population in the UCL.

Van den Bercken, B., Hoogmoed, M., Jansen, R., Lobé, N., Maas, M. and Stenchlak, Z. (2023). Gift to Sobek. Preliminary results of the analysis of a young crocodile mummy in the Allard Pierson. Pp. 63-70 *in* Animals in Religion, Economy and Daily Life of Ancient Egypt and Beyond. UniorPress: Naples.

Viljoen, D.M., Webb, E.C., Myburgh, J.G., Truter, J.C., Lang, J.W. and Myburgh, A. (2023). Adaptive thermal responses of captive Nile crocodiles (*Crocodylus niloticus*) in South Africa. Applied Animal Behaviour Science (https://doi.org/10.1016/j.applanim.2023.106098).

Abstract: The current study assessed the ambient temperatures, and those selected, by captive adult Nile crocodiles on a commercial farm in South Africa. Non-invasive data capture techniques were developed to ensure the crocodiles natural behaviours were not disrupted or altered. Thermal and climate data, over summer and winter seasons, were collected from local weather stations, an on-site Internet of Things system, and a Mavic 2 Enterprise Dual drone. The method developed in this paper transformed relative thermal maps (produced by a DJI Mavic 2 Enterprise Dual drone) into a predictive model in which temperatures were derived to within 2.6°C per pixel of a processed orthophoto. Crocodile thermal and behavioural data were extracted from the drone imagery and juxtaposed with climate and thermal data from the pen. The greatest number of crocodiles were counted during early morning winter flights and the lowest number during late afternoon summer flights. Material (concrete, water, nest, grass/sand) selection by crocodiles varied with season, time of day and daily climatic conditions. Crocodile back temperature (10.2-49.6°C, μ= 30.4°C) ranges fell within those of their positional/environmental (10.6-66.6°C, μ= 28.7°C) temperature range selections. Strong, positive, significant correlations were found between crocodile back temperatures and positional temperatures for both winter and summer seasons, highlighting ectothermy. Application of this methodology on a commercial crocodile farm facilitated the inspection of potential shortfalls of the pens design from a thermal perspective, as well as suggestions for improvements that would ameliorate crocodile thermal discomfort (relating to hyperthermia).

De Almeida Júnior, J.E. (2023). Seleção e uso de habitat pelo Jacaré-paguá (*Paleosuchus palpebrosus*) no Rio Verde, Mato Grosso do Sul. PhD thesis, Universidade Federal de Mato Grosso do Sul, Brazil.

Abstract: Among the Brazilian crocodilians, the Dwarf caiman (*Paleosuchus palpebrosus*) stands out due to its peculiar behaviors and because it is one of the caimans that uses terrestrial environments the most during its life. However, most studies with this species focus on smaller environments, such as streams and streams with cold, crystal clear waters, with research on populations in large rivers being scarce. In this context, the objective of this work was to investigate whether there is a preference for a certain habitat on the part of *P. palpebrosus* in a portion of the Rio Verde, located in the municipality of Água Clara, Mato Grosso do Sul. During a period of 6 months, they were 5 field and remote sensing analyzes were carried out to monitor a population of *P. palpebrosus* (N= 151), investigating a possible preference for a habitat, relating these data to the size of each caiman. The data obtained revealed that caimans have preferences for flooded environments, avoiding open areas and areas close to urbanized areas. Furthermore, the study area and the size of the individuals did not influence the choice of these animals for different environments. This study contributes to knowledge about the ecology of *P. palpebrosus*, which is a relatively little-known species, in the Rio Verde region, in Água Clara, Mato Grosso do Sul. The information obtained in this work can be useful for the management and conservation of the biodiversity in the area, including the identification of priority areas for the conservation and restoration of *P. palpebrosus* habitats and increasing knowledge about the species in previously unknown environments.

Flint, M. and Flint, J. (2023). Use of soybean as an alternative protein source for welfare-orientated production of American alligators (*Alligator mississippiensis*). PeerJ 11: e16321.

Abstract: Soybean meal based diets have been suggested to cause gastrointestinal issues in certain species when used as a protein alternative. Using a randomized design, we tested 1728 alligators in one of 13 communal pens offered one of two diets [seven pens (n= 928) of soybean-based protein diets and six pens (n= 800) of animal-based protein diets] to determine if soybeans would negatively affect the growth, hide quality, behavior and health, when compared with an otherwise identical diet using animal-based protein. Both feeds were nearly identical in composition for protein and fat percentages and identical for all minerals and elements. Crude protein was a minimum of 50%, crude fat a minimum of 12%, crude fiber a minimum of 4%, and phosphorous was maintained at 1%. From this information we estimated the One Welfare of using soy as a protein in commercial diets. Although there was a statistically significant decrease in belly width (p= 0.0009; harvested hide size) for alligators fed soybean-based protein diets, all other measured parameters of soybean vs. animal-based protein diets were comparable, suggesting this environmentally sustainable alternative protein source warrants consideration as a feed base. Weight was not significantly different suggesting either diet would yield similar volumes of meat. Total length was significantly affected by diet. Hide quality was not negatively impacted by protein type, with both diets producing high quality hides free of defects (assessed at the salted hide stage prior to tanning). Behaviors were not influenced by the feed type, with animals fed either diet using the pen structures the same. Further, feeding times were the same suggesting the soybean-based protein diet was equally easy to eat and palatable as the animal-based protein diet. Behavior and feeding suggested soy-based diets do not alter time budgets or activities. There were no differences in the frequency or severity of pathologies for animals fed either diet. Respiratory (lung and trachea as a proxy to measure dust inhalation), gastrointestinal (small intestine as a proxy to measure digestive disturbances), and renal (kidney as a proxy for excretory stress) histopathology demonstrated neither diet was causing overt problems. One Welfare conclusions were feeding a soybean-based protein diet did not cause production or welfare issues. Further, soybean protein-based diets

may be an environmentally sustainable alternative to currently used animal-based diets. Research examining different soybean protein concentrations and sources is warranted.

Mendonça, W.C.S., Duncan, W.P., Vidal, M.D., Magnusson, W.E. and Da Silveira, R. (2023). Blood biochemical reference intervals of Black caimans (*Melanosuchus niger*) and Spectacled caimans (*Caiman crocodilus*) in the Brazilian Amazon region. Journal of Wildlife Diseases (doi: 10.7589/JWD-D-23-00067).

Abstract: Reference intervals for physiologic parameters, crucial for assessing the health status of animals, have been documented for various crocodilian species across the globe. Nonetheless, the establishment of plasma biochemical reference intervals specific to Amazonian crocodilians remains incomplete. In an effort to address this gap, we procured blood samples from 65 black caimans (*Melanosuchus niger*) and 58 spectacled caimans (*Caiman crocodilus*) during the period of September-December 2019 within the Anavilhanas National Park in the Brazilian Amazon region We aimed to define reference intervals for 11 key plasma variables measured, namely glucose, triglycerides, total cholesterol, calcium, magnesium, sodium, potassium, albumin, total protein, uric acid, and urea. In general, the determined blood reference intervals aligned closely with those established for other crocodilian species. Some specific measurements, such as total cholesterol, sodium, and magnesium, exhibited distinct variations based on the species. Furthermore, female black caimans showcased elevated cholesterol levels compared with their male counterparts. Within the spectacled caimans, disparities related to sex were evident solely in the case of electrolytes sodium and potassium, with males demonstrating higher levels compared with females. These reference intervals not only provide data for assessing potential fluctuations in the health of wild or captive Amazonian crocodilians but also hold value for veterinary management.

Huan, E., Otta, G.M.N. and Dangu, I. (2023). Signs of royalty: An analysis of symbols on traditional kings' graves in Raja Prailiu Village. International Journal of Education and Literature.

Abstract: "Signs of Royalty: An Analysis of Symbols on Traditional Kings' Graves in Raja Prailiu Village" is a semiotic study that aims to find out the symbols of the stone tomb carved on the traditional kings' graves and their meanings by using Pierce's theory. All the data gained are analyzed using the descriptive qualitative method. The instruments used in this research are observation and interview. The result of the research showed that there are 12 symbols found on the kings' traditional graves,they are Manu Wulu (roaster), Njara (horse), Tau (human), Ahu (dog), Ana wuya rara (crocodile), Ruha (deer), Lamba (jewelry), Na Ana Lodo Na Ana Wullang (the sun and moon), Ana Kara Wula (turtle), Maduku Pati (coffin bearer), Maduke (animal slaughter), and Papaha Maramba (queen).

Ali, M.J. (2023). Evolutionary aspects of the Lacrimal Drainage System. *In* Atlas of Lacrimal Drainage Disorders. Springer: Singapore.

Abstract: The lacrimal drainage system (LDS) is an ancestral terrestrial adaptation in tetrapod vertebrates and their descendant species. Its evolution parallels that of the vomeronasal organ (VNO) and the Harderian gland. The LDS system varies from species to species, partly anatomically and partly physiologically, with important implications for understanding the evolutionary functions. In squamate reptiles and caecilians, the secretions of the Harderian glands travel through the nasolacrimal duct (NLD) to the vomeronasal organ (VNO, a sensory organ). Other than the function of keeping the eye clean, the lacrimal drainage is believed to transfer the solubilized pheromones to the VNO for it to sense them and initiate corresponding actions. The Harderian gland is more glandular in crocodilians, and a larger amount of secretions pass through the NLD to the oral cavity to moisten the food bolus. The NLD is an important part of the avesuchian head-associated lymphatic system, as the NLD transfers the immunologically rich Harderian gland secretions to the upper respiratory tracts for their subsequent functions.

Ichekor, F.M. (2023). Detection and Antibiotic Resistance of *Shigella* Species Associated with Game Meat in Nigeria. BSc thesis, Mountain Top University, Makogi, Nigeria.

Abstract: Game meat is an important source of nourishment for many populations in low-medium-income countries (LMICs), most importantly in Sub-Saharan Africa. This meat is sourced from wild animals hunted in unregulated conditions, transported to distant markets using minimal or no hygienic measures, and frequently eviscerated 24 hours after death. Given the potential significance of animals as a reservoir for bacterial zoonotic diseases, game meat could pose a significant public health risk in Sub-Saharan Africa. The purpose of this study was to determine the presence of *Shigella* spp in game meat samples (pangolin, deer, frog, porcupine, bush pig, buffalo, bush dog, grass cutter, gazelle, alligator, monitor lizard, monkey, squirrel, bush rat, jackal and duck) collected from various cities in Nigeria. A total of 22 game meat were sampled. *Shigella* spp. were isolated from the game meats using a selected media and pre-enrichment techniques. The identification of *Shigella* was carried out using colony characteristics, the Gram reaction and biochemical tests. Single and multidrug susceptibility testing was performed on selected Kirk-Bauer disc diffusion technique, *Shigella* spp. was detected in all of the game meat tested. Similarly, the selected isolates demonstrated resistance to at least three or more of the twelve antibiotics tested for multidrug resistance while some showed resistance to single drug resistant testing. Single-drug resistance was observed in amikacin, erythromycin (100%) and tetracycline (40%). Multidrug resistance to cefoperazone (20%), vancomycin (20%), meropenem (40%), and cefuroxime (60%) was most prominent in isolates tested. The presence of *Shigella* spp. in ready to-eat game meat is an indication that people are at risk of severe infections which could be difficult to treat during antibiotics therapy. However, Ciprofloxacin was found to be sensitive so it could be used for treatment. Therefore, the adoption of safety measures such as the Hazard Analysis and Critical Control Point (HACCP) principle which provides the framework for monitoring food system from farm-fork is needed in the game meat supply chain to reduce the risk of foodborne illnesses.

Mobaraki, A., Erfani, M., Abtin, E., Brito, J.C., Wei C.T., Ziegler, T. and Rödder, D. (2023) Last chance to see? Iran and India as strongholds for the Mugger Crocodile (*Crocodylus palustris*). Salamandra 59(4): 327-335

Abstract: Justified predictions of future changes in species distributions are necessary for defining adequate conservation plans over space and time. The Marsh or Mugger Crocodile (*Crocodylus palustris*) is native to freshwater habitats of the Indian subcontinent and in southeastern Iran. Habitat loss is currently the most important threat to crocodile dispersal and persistence, and climate change will likely exert increasing pressure on populations. This study used ecological niche modelling (maximum entropy) to predict the current distribution of this species and project it to future climatic conditions. For this purpose, 380 occurrence records were used for model computation and environmental data were obtained from Worldclim 2.0. Averages of eight global circulation model outputs, assuming four IPCC6 per story lines in 2081-2100, were used as future ensembles. Furthermore, future possible anthropogenic pressure was quantified using economic growth models. Temperature Annual Range was the climatic variable with the highest contribution to the modelling. Presently, most potential suitable habitats are located in Sri Lanka, in the southeastern peninsular of India, the tropical moist forest along the west coast of India, the border region between Nepal and India, and the south coasts of Iran and Pakistan. In the future,

these suitable habitats are predicted to be further fragmented and to shift farther inland. Additional threats may arise from increased human/crocodile conflicts due to human population growth. Conservation should therefore focus on those areas that remain climatically comparatively stable with a low potential of human/crocodile conflicts. Key areas are located in the northern parts of India and at the westernmost range limits of this species in Iran.

Francis, C., Hale, A., Berken, J., Joanen, T. and Merchant, M. (2023). Morphological and ontogenetic skin color changes in the American alligator (*Alligator mississippiensis*). Animals 13(22): 3440.

Abstract: To assess skin color change in alligators, we maintained animals in differently lighted environments and also measured skin colors in an ontogenetic series of wild animals. Juvenile alligators maintained in black enclosures exhibited a gradual lightening of skin color when shifted to white enclosures, and these observed changes were reversible. A histological examination of the skins of alligators maintained in dark tanks showed that the dermis exhibited a dense layer of pigmented cells, while samples from the same animals in light environments exhibited a more diffuse pigmented layer. As alligators grow, they exhibit an ontogenetic loss of stripes that may aid in crypsis and predation. Hatchlings have intense black and yellow vertical stripes that darken with age; adults are a more homogenous black/gray color. Since alligators live in temperate climates and adults have lower surface area/volume ratios, which can be detrimental for the absorption of radiant energy, the darker color of larger animals may also aid in thermoregulation. Alligators at the northern end of their range, with colder climates, exhibited darker skin tones, and the ontogenetic extinction of stripes occurred at a more accelerated rate compared to animals in southern, warmer regions, supporting the idea that latitude-dependent ontogenetic color shift has a role in thermoregulation.

Hernandez-Rangel, S.H., Morales-Betancourt, M.A., Muniz, F.L., Vargas-Ramirez, M, Rojas-Runjaic, F.J.M., Lasso, C.A. and Caballero, S. (2023). Phylogenetic identity and population structure of the dwarf caimans *Paleosuchus* spp. in the Orinoco basin of Colombia and Venezuela: filling gaps. Biological Journal of the Linnean Society (https://doi.org/10.1093/biolinnean/blad145).

Abstract: Dwarf caiman species of the genus *Paleosuchus* (*Paleosuchus palpebrosus* and *Paleosuchus trigonatus*) are old, widespread crocodilian lineages with populations affected by habitat modification. For both species, phylogeographical studies revealing crucial information have already been performed, but for important ecoregions, such as the Orinoco, knowledge is lacking. In this study, the phylogenetic identity of individuals of *Paleosuchus* spp. from the Orinoco basin of Colombia and Venezuela was evaluated. The genetic structure of the two species of *Paleosuchus* was also determined and their genetic diversity quantified. The results show a marked genetic structuring in both species, also indicating that the populations of *P. trigonatus* and *P. palpebrosus* of the Orinoco basin are well differentiated from those of other hydrographic basins. For Colombia, it was possible to infer that there are two independent management units for both species (Orinoco and Amazonas) and that the populations of the Orinoco basin present high genetic and haplotypic diversity. In Venezuela, only one management unit was identified for each species. This finding, together with the results of previous studies, show that, in total, there are at least five management units for *P. palpebrosus* and six for *P. trigonatus*, throughout their distribution areas. It is necessary to take this information into account when establishing conservation strategies for these species, although it is stressed that the geographical sampling must be improved in future phylogeographical studies, because information gaps persist at the geographical level.

Elejalde-Cadena, N.R., Hernandez, D., Capitelli, F., Islas, S.R., Rosales-Hoz, M.J., Zema, M., Tarantino, S.C., Siliqi, D. and Moreno, A. (2023). Influence of intramineral proteins on the growth of carbonate crystals using as a scaffold membranes of ratite birds and crocodiles eggshells. Membranes 13(11): 869.

Abstract: The lack of information on structural basis where proteins are involved, as well as the biomineralization processes of different systems such as bones, diatom frustules, and eggshells, have intrigued scientists from different fields for decades. This scientific curiosity has led to the use of methodologies that help understand the mechanism involved in the formation of these complex structures. Therefore, this work focuses on the use of eggshell membranes from different species of ratites (emu and ostrich) and reptiles (two species of crocodiles) as a model to differentiate biocalcification and biosilicification by introducing calcium phosphate or silica inside the membrane fiber mantles. We performed this to obtain information about the process of eggshell formation as well as the changes that occur in the membrane during crystal formation. In order to identify and understand the early processes leading to the formation of the microstructures present in the eggshell, we decided to carry out the synthesis of silica-carbonate of calcium, barium, and strontium called biomorph in the presence of intramineral proteins. This was carried out to evaluate the influence of these proteins on the formation of specific structures. We found that the proteins on untreated membranes, present a structural growth similar to those observed in the inner part of the eggshell, while in treated membranes, the structures formed present a high similarity with those observed in the outer and intermediate part of the eggshell. Finally, a topographic and molecular analysis of the biomorphs and membranes was performed by scanning electron microscopy (SEM), Raman and Fourier-transform Infrared (FTIR) spectroscopies.

Wang, J., Zheng, J., Zhao, Y. and Yang, K. (2023). Structure design and coordinated motion analysis of bionic crocodile robot. arXiv (https://doi.org/10.48550/arXiv.2311.01764).

Abstract: Crocodiles, known as one of the oldest and most resilient species on Earth, have demonstrated remarkable locomotor abilities both on land and in water, evolving over millennia to adapt to diverse environments. In this paper, we draw inspiration from crocodiles and introduce a highly biomimetic crocodile robot equipped with multiple degrees of freedom and articulated trunk joints. This design is based on a comprehensive analysis of the structural and motion characteristics observed in real crocodiles. The bionic crocodile robot has the problem of limb-torso incoordination during movement, in order to solve this problem, we apply the D-H method for both forward and inverse kinematics analysis of the robot's legs and spine. Through a series of simulation experiments, we investigate the robot's stability of motion, fault tolerance, and adaptability to the environment in two motor pattern: with and without the involvement of the spine and tail in its movements. Experiment results demonstrate that the bionic crocodile robot exhibits superior motion performance when the spine and tail cooperate with the extremities. This research not only showcases the potential of biomimicry in robotics but also underscores the significance of understanding how nature's designs can inform and enhance our technological innovations.

Arias, A.A. and Azizi, E. (2023). Modulation of limb mechanics in alligators moving across varying grades. Journal of Experimental Biology (https://doi.org/10.1242/jeb.246025).

Abstract: Graded substrates require legged animals to modulate their limb mechanics to meet locomotor demands. Previous work has elucidated strategies used by cursorial animals with upright limb posture, but it remains unclear how sprawling species like alligators transition between grades. We measured individual limb forces and three-dimensional kinematics as alligators walked steadily across level, 15° incline, and 15° decline conditions. We compare our results to the literature to determine how limb posture alters strategies for managing the energetic variation that accompanies shifts in grade. We found that juvenile alligators maintain

spatiotemporal characteristics of gait and locomotor speed while selectively modulating craniocaudal impulses (relative to level) when transitioning between grades. Alligators seem to accomplish this using a variety of kinematic strategies, but consistently sprawl both limb pairs outside of the parasagittal plane during decline walking. This latter result suggests alligators and other sprawling species may use movements outside of the parasagittal plane as an axis of variation to modulate limb mechanics when transitioning between graded substrates. We conclude that limb mechanics during graded locomotion are fairly predictable across quadrupedal species, regardless of body plan and limb posture, with hindlimbs playing a more propulsive role and forelimbs functioning to dissipate energy. Future work will elucidate how shifts in muscle properties or function underlie such shifts in limb kinematics.

Flint, M., Flint, J.B. and Miller, J.D. (2023). Techniques to assess reproductive status in adult female American alligators (*Alligator mississippiensis*) using laparoscopic examination. PLoS ONE 18(11): e0287140

Abstract: This protocol describes a minimally invasive surgical technique and approach to successfully examine the gonads of live female American alligators as part of a reproductive examination used in conservation medicine and biology. Best practices are based on examination of over 80 American alligators in the last two years adapting principles derived from other reptilian megafauna species. This protocol is designed for appropriately qualified veterinarians and biologists working in the field. We show likely reproductive tract presentations with respect to breeding status and environmental cues to help guide interpretation of observations. The laparoscopic approach and findings presented here provide tools to safely clinically examine animals in a welfare-oriented way that will advance our understanding of crocodilian reproduction. This technique has not previously been described in this species.

Faulkner, P.C., Hala, D., Shimskie, J., Johnson, R., Schneider, A., Cubbage, T., Lozano, N. and Petersen, L.H. (2023). Juvenile American alligators (*Alligator mississippiensis*) use behavioral thermoregulation to cope with dehydration and salt-loading when chronically exposed to 12‰ saltwater. Animal Behavior and Cognition, 10(1) (https://doi.org/10.26451/abc.10.01.01.2023).

Abstract: American alligators (*Alligator mississippiensis*) are native to freshwater habitats in the Southeastern United States. These areas are susceptible to salinity increases due to extreme weather events (eg hurricanes) and climate change. The goal of this study was to investigate behaviors in juvenile alligators exposed to 12‰ saltwater for five weeks. Sixteen alligators were maintained in an experimental tank with 90 L of water and a heat lamp overhanging a basking plate. Observations were conducted in freshwater (prior to exposure to saltwater) and over the course of 5 weeks in 12‰ saltwater. This allowed for comparison of behaviors in freshwater and in saltwater in the same group of animals. Behaviors related to thermoregulation (basking and staying in the water) and feeding were recorded via instantaneous sampling, in which sampling intervals of 1 min occurred throughout a 20 min observation period. Saltwater-exposed alligators reduced foraging and feeding within the first week of saltwater exposure and spent significantly less time basking compared with freshwater observations. Furthermore, significantly fewer animals chose to bask over the course of 5 weeks in saltwater. A novel behavior, never seen in freshwater, was the closing of the outer eyelids when alligators were in the saltwater. Collectively, the present study demonstrates that chronic saltwater exposure has significant impact on the thermoregulatory behavior in juvenile alligators concomitantly exposed to dehydration and salt-loading without access to freshwater. As alligator hatchlings emerge during peak hurricane season, the survivability of hatchlings may be compromised if access to freshwater is unattainable.

Panthum, T., Ariyaraphong, N., Wongloet, W., Wattanadilokchatkun, P., Laopichienpong, N., Rasoarahona, R., Singchat, W., Ahmad, S.F., Kraichak, E., Muangmai, N., Duengkae, P., Fukuda, Y., Banks, S., Temsiripong, Y., Ezaz, T. and Srikulnath, K. (2023). Preserving pure Siamese crocodile populations: A comprehensive approach using multi-genetic tools. Biology 12: 1428 (https://doi.org/10.3390/biology12111428).

Abstract: Hybrids between the critically endangered Siamese crocodile (*Crocodylus siamensis*) and least-concern saltwater crocodile (*C. porosus*) in captive populations represent a serious challenge for conservation and reintroduction programs due to the impact of anthropogenic activities. A previous study used microsatellite and mitochondrial DNA data to establish the criteria for identifying species and their hybrids; however, the results may have been influenced by biased allelic frequencies and genetic drift within the examined population. To overcome these limitations and identify the true signals of selection, alternative DNA markers and a diverse set of populations should be employed. Therefore, this study used DArT sequencing to identify genome-wide single nucleotide polymorphisms (SNPs) in both species and confirm the genetic scenario of the parental species and their hybrids. A population of saltwater crocodiles from Australia was used to compare the distribution of species-diagnostic SNPs. Different analytical approaches were compared to diagnose the level of hybridization when an admixture was present, wherein three individuals had potential backcrossing. Approximately 17.00-26.00% of loci were conserved between the Siamese and saltwater crocodile genomes. Species-diagnostic SNP loci for Siamese and saltwater crocodiles were identified as 8051 loci and 1288 loci, respectively. To validate the species-diagnostic SNP loci, a PCR-based approach was used by selecting 20 SNP loci for PCR primer design, among which 3 loci were successfully able to differentiate the actual species and different hybridization levels. Mitochondrial and nuclear genetic information, including microsatellite genotyping and species-diagnostic DNA markers, were combined as a novel method that can compensate for the limitations of each method. This method enables conservation prioritization before release into the wild, thereby ensuring sustainable genetic integrity for long-term species survival through reintroduction and management programs.

Martin, J.E., Naksri, W., Lauprasert, K., Wongko, K., Chompusri, S., Sila, S. and Claude, J. (2023). An early diverging crocodylid from the Middle Miocene of Thailand highlights the role of SE Asia for the radiation of the Crocodyloidea. Historical Biology (https://doi.org/10.1080/08912963.2023.2278152).

Abstract: The Neogene period witnessed the radiation of modern crocodylian genera, as evidenced from their fossil record in intertropical zones. Despite its recognition as a modern biodiversity hotspot, South East Asia remains undersampled for that age bin. Here, we describe a new crocodylian from northern Thailand, *Antecrocodylus chiangmuanensis* n. gen. n. sp. from the Middle Miocene lignite seams of Chiang Muan and refer to it other specimens from the nearby lignite seams of Mae Moh. The holotype specimen preserves the posterior half of the skull and mandible. Anatomical observations are aided by medical computed tomography. A phylogenetic analysis places the new taxon in a basal position relative to Crocodylidae. This discovery highlights the underrated fossil record of Neogene crocodyloids in Asia compared to Africa or Australia and allows us to reconsider palaeobiogeographic relationships between supposed endemic clades.

Fukuda, Y., Moritz, C., FitzSimmons, N.N., Jang, N., Webb, G., Lindner, G., Campbell, H., Christian, K., Leeder, S. and Banks, S. (2023). Natal origin and dispersal of problem saltwater crocodiles in the Darwin Harbor, Australia. Journal of Wildlife Management 2023: e22525.

Abstract: Management programs that successfully recovered wild

saltwater crocodile (*Crocodylus porosus*) populations in theNorthern Territory of Australia did so with an expanding commitment to maintaining public safety. One aspect of the program is the ongoing removal of resident and immigrant crocodiles within Darwin Harbor (since 1979), the main urban center. We determined the likely sources of crocodiles caught as problem animals between 2015-2017 by comparing recently developed methods for population assignment. Depending on the assignment model used, we estimated that between 30% and 50% of crocodiles in Darwin Harbor originated from the Adelaide and Mary Rivers, and the Kakadu region east of Darwin, and between 20% and 30% of crocodiles originated from the Finniss, Reynolds, and Daly Rivers southwest of Darwin. Saltwater crocodiles occur at particularly high densities in these catchments. The remainder came from a mixture of different sources across the NorthernTerritory. The most common animals captured were immature (150-180 cm) males that have traveled 100-200 km. We didnot identify any relationships between the distance from theinferred origin to Darwin Harbor and the size and sex of the crocodiles, or the year of capture. The targeted removal of crocodiles from specific sites such as Darwin Harbor, near where most people live, improves public safety in the highest risk areas, without compromising abundant source populations in most areas.

Du Plooy, K.J., Swan, G.E., Myburgh, J.G. and Zeiler, G.E. (2023). Electroencephalogram (EEG) assessment of brain activity before and after electrical stunning in the Nile crocodile (*Crocodylus niloticus*). Scientific Reports 13: 20250.

Abstract: Electrical stunning is used to capture crocodiles to perform routine management procedures. It is essential from a welfare point that electrical stunning must cause unconsciousness in animals. However, there is no information of whether or not electrical stunning causes unconsciousness in the Nile crocodile (*Crocodylus niloticus*). The purpose of the study was to assess brain activity before and after electrical stunning in crocodiles using a 5-channel referential electroencephalogram analysis to determine consciousness. Behavioural indicators and electroencephalogram recordings of 15 captive-bred crocodiles were captured and analysed using power spectral density analysis immediately before and after stunning and then at 60 s intervals until 5 min post-stunning. A standardised stun of 170 Volts was applied for 5-7 s on the wetted neck. Unconsciousness was defined as a decrease in alpha wave power and increase in delta wave power. Three of the electroencephalograms could not be assessed. Unconsciousness was identified in 6 out of 12 crocodiles and lasted for an average for 120 s. An increase in electroencephalogram waveform amplitude and tonic-clonic seizure-like waveform activity and behaviour indicators were not reliable indicators of unconsciousness. Further research should be focused on improving the efficiency and reliability of electrical stunning.

Platt, S.G., White, J.C., Boutxakittilath, S., Phasavath, D., Thongsavath, O., McCaskill, L.D., Leslie, S.C. and Rainwater, T.R. (2023). Evaluating the use of a quadcopter drone to detect Siamese crocodile (*Crocodylus siamensis*) nests in Lao PDR, with incidental observations of female nest attendance. Reptiles & Amphibians 30: e19950.

Gray, R.J. and Gazagne, E. (2023). Feasibility assessment of commercially available Unmanned Aerial Vehicle sensor and payload functions for crocodile population surveys. Herpetology Notes 16: 907-913.

Abstract: In recent years, there has been a growing interest in using Unmanned Aerial Vehicles (UAVs) for monitoring crocodile populations. We therefore assessed the feasibility and effectiveness of using commercially available UAV features for monitoring the population of critically endangered Siamese crocodiles (*Crocodylus siamensis*) in Crocodile Lake (Bàu Sấu), Nam Cat Tien National Park, Vietnam. The study deployed a DJI Mavic 2 Enterprise Advanced drone with a Smart Controller, a Thermal Infrared (TIR) sensor, a RGB visual camera, and a spotlight payload. The study conducted manual and pre-programmed systematic mission flights above Crocodile Lake to include heterogenous portions of the landscape and to assess variable crocodile detectability over areas of open land, vegetation, and open water. The results of our study show that systematic night flights at 20 m altitude using a DJI dual spotlight at a 45° downward angle, coupled with RGB and co-registered TIR sensors (with continuous gradient palettes on the flight controller) also set to 45° angle, are effective for crocodile population monitoring. Although brief, our study shows that conducting UAV flights in both day- and night-time conditions using TIR, RGB, and spotlight payloads can provide a comprehensive understanding of crocodile population given various strengths and limitations of each. Finally, our experience allows us to provide feasibility recommendations for the use of UAVs to monitoring of crocodile populations in a global context.

Pérez-Fleitas, E., Milián-García, Y., Sosa-Rodríguez, G., Amato, G., Rossi, N., Shirley, M.H. and Hanner, R.H. (2023). Environmental DNA-based biomonitoring of Cuban *Crocodylus* and their accompanying vertebrate fauna from Zapata Swamp, Cuba. Scientific Reports 13: 20438.

Abstract: Crocodylians globally face considerable challenges, including population decline and extensive habitat modification. Close monitoring of crocodylian populations and their habitats is imperative for the timely detection of population trends, especially in response to management interventions. Here we use eDNA metabarcoding to identify the Critically Endangered *Crocodylus rhombifer* and the Vulnerable *C. acutus*, as well as vertebrate community diversity, in Cuba's Zapata Swamp. We tested four different primer sets, including those used previously in *Crocodylus* population genetic and phylogenetic research, for their efficiency at detecting crocodylian eDNA. We detected *C. rhombifer* eDNA in 11 out of 15 sampled locations within its historical geographic distribution. We found that data analyses using the VertCOI primers and the mBRAVE bioinformatics pipeline were the most effective molecular marker and pipeline combination for identifying this species fromenvironmental samples. We also identified 55 vertebrate species in environmental samples across the four bioinformatics pipelines - ~85% known to be present in the Zapata ecosystem. Among them were 8 species previously undetected in the area and 8 alien species, including known predators of hatchling crocodiles (eg *Clarias* sp.) and egg predators (eg *Mus musculus*). This study highlights eDNA metabarcoding as a powerful tool for crocodylian biomonitoring within fragile and diverse ecosystems, particularly where fast, non-invasive methods permit detection in economically important areas and will lead to a better understanding of complex human-crocodile interactions and evaluate habitat suitability for potential reintroductions or recovery programs for threatened crocodylian species.

Ojeda Adame, R.A., Gerritsen, P.R.W. and Iñiguez Dávalos, L.I. (2023). Conocimientos y percepciones sobre el cocodrilo americano (*Crocodylus acutus*) por pobladores de la Manzanilla del Mar, Costa de Jalisco, México. Sociedades Rurales, Producción y Medio Ambiente 23(45): 97-113.

Abstract: Sociological research on the relationship human-cocodrile is a research field of recent attention and the social effects of ecotourism are poorly understood. The present research analyzes the effect of this activity on the perception and knowledge of the biology, conservation status, risks, and benefits of crocodiles for the people of La Manzanilla del Mar, in the Coastal zone of Jalisco state, western Mexico. Through the application of 40 self-completion surveys to residents unrelated to the tourist project in the community, our results show little knowledge about the reproduction and ecological role of the saurian. It is considered as an abundant species and with

a limited dangerousness. It is also associated with tourism and with the production of economic income for the community. Finally, it was mentioned that the reptile's diet is composed of fish waste provided by tourists and residents. The results show that the local people's coexistence with the crocodile is limited to this moment, influencing their knowledge and their perception.

Zhang, M., Zeng, Y., Guo, H., Wu, X., Meng, Z., Yin, R. and Luo, J. (2023). Structural and functional properties of protein hydrolysates from myofibrillar protein of crocodile (Crocodylus siamensis) meat. Available at SSRN: https://ssrn.com/abstract=4635540 or http://dx.doi.org/10.2139/ssrn.4635540.

Abstract: In this study, three proteases (papain, neutral protease, bromelain) were employed to hydrolyze crocodile (Crocodylus siamensis) myofibrillar protein (MP), effects of hydrolysis duration on functional and structural properties of MP hydrolysates was investigated. The findings revealed that solubility of all hydrolysates exceeded 60%, with the highest reaching 96.69%. The emulsifying activity of neutral protease hydrolysates exhibited a significant superiority over the other two hydrolysates ($P<0.05$). The Fe2+ chelating and DPPH radical scavenging activity of hydrolysates ranged from 20% to 60%, and 60% to 90%, respectively. Based on the experiment results, the hydrolysates of papain at 1h, neutral protease at 1h, and bromelain at 2h were used for structural analysis. Compared to MP, the secondary structure of hydrolysates showed a reduction of 9.6%, 15.17%, and 4.7% in α-helix and the increase of 42.40%, 29.60%, and 44.20% in β-fold content of papain, neutral protease and bromelain hydrolysates respectively, suggesting the transition from spiral to folding structure and the exposure of hydrophobic group, which was proved by free amino acid analysis. SEM results confirmed the alterations in MP structure. The molecular weight distributions of three hydrolysates were predominantly below 1000 Da, demonstrating that crocodile MP was effectively hydrolyzed into bioactive peptides.

Stark, A.M., Nohrenberg, M., Draper, A.D.K., McMahon, K.E., Hewitt, T.A., Lomas, K. and Krause, V.L. (2023). A cluster of leptospirosis cases associated with crocodile workers in the Northern Territory, Australia, 2022. Communicable Diseases Intelligence 47 (https://doi.org/10.33321/cdi.2023.47.70).

Abstract: Leptospirosis is a worldwide zoonotic waterborne disease endemic in tropical and subtropical climates. Outbreaks have been observed in the Northern Territory (NT) of Australia. We briefly described the epidemiology of leptospirosis in the NT between 2012 and 2022, and undertook an investigation of a cluster of three leptospirosis cases observed in crocodile workers between January and December 2022 in the Top End of the NT. A descriptive case series was conducted to investigate the cluster; all three cases were male and non-Aboriginal with a median age of 46.5 years; none took chemoprophylaxis; only one of the three cases reported wearing appropriate protective attire; all reported receiving limited to no education about personal protective measures from their associated workplaces. Higher than average rainfall in both February and December 2022 likely contributed to the increased risk of infection in those months. Changing climate patterns are likely to result in more frequent periods of heavy rain, and risk of contracting leptospirosis in the NT may increase, particularly for those who work in wet and muddy conditions. Promoting the use of protective workplace clothing and equipment, the use of waterproof dressings for skin abrasions, regular hand hygiene, and the consideration of chemoprophylaxis in certain circumstances may prevent future cases.

Lee, H.W. (2023). Evolution and Development of the Pseudosuchian Skull Table Sutures and its Impact on the Cranial Topology. PhD thesis, University of Hong Kong, Pokfulam, Hong Kong SAR.

Abstract: Reorganization (ie rearrangement, fusion, or loss) of cranial bones is one of the most striking ways to introduce evolutionary novelties in the cranium. It is accomplished by the co-option (reuse) of pre-existing developmental processes and morphological characteristics. To understand how this process works from both macro-evolutionary and developmental directions, I looked at the cranial reorganization of pseudosuchians, a reptilian lineage that includes crocodiles and their common ancestors. Although only a few modern crocodylians still exist today, extinct pseudosuchians greatly diversified and prospered from the Mesozoic to the Cenozoic era and adapted to multiple ecological niches, such as land, saltwater and freshwater habitats. Their sturdy cranial fossils are often well-preserved and can represent the major evolutionary transitions in the pseudosuchian life history. Following the structure of a typical evo-devo study, I began with exploring the macroevolution of cranial reorganization in pseudosuchians (Chapter 1), compared these characteristics with its sister group, the dinosaurs (Chapter 2), chose a specific feature (i.e. suture anatomy of the frontal and parietal bones) and looked at their morphological changes during development (Chapter 3), and attempted to learn more about their developmental mechanism (Chapter 4). Multiple interdisciplinary techniques were used: computed tomography scan of crocodylian skulls, computer modeling of the cranial arrangement called Anatomical Network Analysis (AnNA), geometric morphometrics to record the diversity of suture shape, and histology, and immunofluorescence to identify key proteins involved in formation of bones. Using AnNA, I showed that pseudosuchians had a smaller reorganization compared to avialans (Chapter 2). This macroevolutionary reorganization manifested as a skull bone reduction from crown pseudosuchians to modern crocodylians and was associated with the fusion of the frontals and parietals (Chapter 1). The frontal and parietal bones and their homologues were identified as the cranial bones with the greatest burden (ie highly connected to other bones and subjected to higher levels of constraint) in archosaurs (Chapter 2). Fusion of these bones is an excellent example of heterochrony: the development stage for complete fusion of interfrontal and interparietal suture shifted from juveniles in eusuchian (stem crocodylian) to embryos in crocodylians (Chapter 3). Similarities with other amniotes also revealed a conserved pattern of sutural form: sutures begin from a simple morphotype (i.e., abutting joint) with minimal interdigitations, and then, as they receive mechanical input, diversify in post-embryonic stages by either fusing, maintaining their embryonic form, or increasing interdigitation and joint complexity into their lineage-specific form (Chapter 3). Histology and immunofluorescence showed the ossification of the frontal and parietal bones rely on the mechanosensitive Wnt and BMP signaling pathways and osteoblast-osteoclast balance (Chapter 4). The intertwining signaling pathway and patterns of ossification also show that the interdependent development of the forebrain, skull roof/skull table, and facial bones.

Vyas, R. (2023). Critiques: On the first sighting report of Mugger crocodile from the Purna River, South Gujarat, India. Reptiles & Amphibians 30: e18961.

Terebiznik, M., Farrell, M. and Rollinson, N. (2023). Ontogenetic shifts in sex ratios support multiple adaptive explanations for temperature-dependent sex determination. Research Square (https://doi.org/10.21203/rs.3.rs-3569199/v1).

Abstract: Temperature-dependent sex determination (TSD) is found in all reptile groups, but its adaptive significance is a mystery. This is because most TSD reptiles feature extreme longevity, so assessing lifetime fitness is incredibly difficult. Here we combine classical sex ratio theory with a dataset of stage-specific sex ratios from a diversity of wild reptile populations to infer patterns of sex-specific mortality (fitness) across ontogeny. We disentangle whether there is a single or multiple adaptive explanations for TSD, provide insight into what those explanations are, and align the adaptive explanations with major reptile clades. We find that TSD evolved

in turtles and crocodilians so that males develop in high-quality patches, supporting an extension of the Trivers-Willard hypothesis where the fitness of males under sexual selection is more sensitive to body condition than female fitness. We further find that stage-specific patterns of mortality are different in squamates, where TSD may have evolved to match females with high-quality patches that facilitate early maturation and high fecundity. We suggest if TSD evolved in long-lived reptiles because incubation temperature is a pervasive agent that influences stress, then it may be embryonic stress in general, not just thermal stress, that is the fundamental driver of TSD evolution.

Taylor, E., Cramberg, M., Parker, S., Scott, A., Sopko, S., Swords, A. and Young, B.A. (2023). The presence of a foramen of Luschka in the American alligator (*Alligator mississippiensis*) and the continuity of the intraventricular and subdural spaces. Journal of Anatomy (doi: 10.1111/joa.13972).

Abstract: In humans and most mammals, there is a notch-like portal, the foramen of Luschka (or lateral foramen), which connects the lumen of the fourth ventricle with the subdural space. Gross dissection, light and scanning electron microscopy, and μCT analysis revealed the presence of a foramen of Luschka in the American alligator (*Alligator mississippiensis*). In this species, the foramen of Luschka is a notch in the dorsolateral wall of the pons immediately caudal to the peduncular base of the cerebellum, near the rostral end of the telovelar membrane over the fourth ventricle. At the foramen of Luschka there was a transition from a superficial pia mater lining to a deep ependymal lining. There was continuity between the lumen of the fourth ventricle and the subdural space, via the foramen of Luschka. This anatomical continuity was further demonstrated by injecting Evans blue into the lateral ventricle which led to extravasation through the foramen of Luschka and pooling of the dye on the lateral surface of the brain. Simultaneous subdural and intraventricular recordings of cerebrospinal fluid (CSF) pressures revealed a stable agreement between the two pressures at rest. Perturbation of the system allowed for static and dynamic differences to develop, which could indicate varying flow patterns of CSF through the foramen of Luschka.

Hilevski, S., Ciocan, H., Bassetti, L. and Siroski, P.A. (2023). Relationship between skin colour, conjunctivitis, and dermatitis in captive *Caiman latirostris* in Argentina. Herpetology Notes 16: 847-854.

Abstract: The commercial production of crocodilians for skin and meat has been considered an important industry in the world, with skin being the most valuable product, while the meat is considered a by-product. This study was designed to identify some diseases that can affect crocodilians farmed in Argentina, examining the relationships between skin colour and these diseases. Each caiman was classified according to their skin colour and kind of diseases (conjunctivitis or dermatitis). In broad-snouted caimans the prevalence of conjunctivitis was 0.41, and dermatitis was 0.23. Statistical tests indicate that there may be a relationship between the skin colour and health status of the caiman, where the dark-skin animals appear healthier (35.76%) than the light-skin animals (15.89%), where these last are more vulnerable to suffer ocular diseases, and skin diseases at the same time (14.57%). In addition, the body mass and length of healthy animals (dark and light) were higher than caimans with eye disease or with both associated diseases. These results may help crocodilians farms caring by isolation of susceptible animals, establishing stricter criteria for health status. This may imply a decrease in diseases that affect the quality of the skin and the loss of individuals, with a consequent increase in profits obtained by the industry.

Tanpradit, N., Thongdee, M., Sariya, L., Paungpin, W., Chaiwattanarungruengpaisan, S., Sirimanapong, W., Kasantikul, T., Phonarknguen, R., Punchukrang, A., Lekcharoen, P. and Arya, N. (2023). Epidemiology of *Chlamydia* sp. infection in farmed Siamese crocodiles (*Crocodylus siamensis*) in Thailand. Acta Veterinaria Scandinavica 65: 50.

Abstract: Although *Chlamydia* sp. causes widespread disease outbreaks in juvenile crocodiles in Thailand, data regarding the epidemiology, and risk factors of such infections are limited. The aim of this study was to investigate the prevalence and possible risk factors associated with *Chlamydia* sp. infections on Siamese crocodile (*Crocodylus siamensis*) farms in Thailand. A cross-sectional study was conducted from July to December 2019. Samples were collected from 40 farms across six regions in Thailand. Conjunctival, pharyngeal, and cloacal swab samples were analyzed for Chlamydiaceae nucleic acids using semi-nested PCR followed by phylogenetic analysis based on the ompA gene fragment. Risk factors of infection were analyzed using chi-square and univariate regression to calculate odds ratios. The prevalence of *Chlamydia* sp. infection across all regions was 65%. The ompA phylogenetic analysis showed that *Chlamydia* sp. detected in this study was genetically closely related to *Chlamydia crocodili* and *Chlamydia caviae*. The risk factors for infection were water source, reusing treated wastewater from the treatment pond, not disposing of leftover food, low frequency of water replacement in the enclosure of juvenile crocodiles, and lack of water replacement after the death of a crocodile. The prevalence of *Chlamydia* sp. infection in farmed crocodiles in Thailand was 65% during the study period. Cloacal swabs were superior to conjunctival and pharyngeal swabs due to their higher sensitivity in detecting *Chlamydia* sp., as well as their lower invasiveness. Good management and biosecurity in crocodile farming can reduce the risk of *Chlamydia* sp. infection.

Morris, J.G.L. and Parsons, J.J. (2023). The various ways in which birds blink. Animals 13(23): 3656.

Abstract: There has, to date, been no systematic study of the various ways in which birds blink. Digital video recordings were made, and studied using still frames, of 524 bird species, mainly in zoos but also in the wild. Videos on 106 species from various sites on the internet were studied, some of which we had also videoed, giving a total of 591 (out of a possible 10,000) species from all 43 orders and 125 (out of a possible 249) families. Digital video recordings were also made of 15 (out of a possible 24) species of crocodile. Three types of blink were observed in birds: (1) Nictitating membrane blinks were rapid and brief (phasic) and occurred mainly on head movement. (2) Upper lid blinks were seen in parrots, owls, pigeons and some others. These were also rapid and brief and accompanied nictitating membrane blinks. (3) Lower lid blinks were slow and sustained (tonic) and occurred with drowsiness and preening. Nictitating membrane blinks and lower lid blinks were seen in crocodiles but not upper lid blinks. Globe retraction, where the eyeball is pulled into the orbit of the skull during a blink, was seen in crocodiles but not birds. Phasic blinks remove debris and moisten the cornea, essential for allowing oxygen to diffuse into the cornea, which has no blood supply. Tonic blinks are probably mainly protective. The orders of birds which have upper lid blinking are not closely related and this feature is probably the result of convergent evolution.

Stone, T.C. and Davis, K.J. (2023). An unmanned aerial vehicle pipeline to estimate body volume at scale for ecological monitoring. bioRxiv (doi: https://doi.org/10.1101/2023.11.23.567408).

Abstract: Demographic data are essential to construct mechanistic models to understand how populations change over time and in response to global threats like climate change. Existing demographic data are either lacking or insufficient for many species, particularly those that are challenging to study, such as marine mammals. A pipeline for collecting accurate demographic data to construct robust demographic models at scale would fill this knowledge gap for many species, including marine mammals like pinnipeds (seals, sea lions,

and walruses). We introduce a non-invasive pipeline to estimate the 3D body size (volume) of species that will allow monitoring at high spatial and temporal scales. Our pipeline integrates 3D structure-from-motion photogrammetry data collected via planned flight missions using off-the-shelf, multirotor unmanned aerial vehicles (UAVs). We apply and validate this pipeline on the grey seal *Halichoerus grypus*, a marine species that spends much of its time at sea but is predictably observable during its annual breeding season. We investigate the optimal ground sampling distance (GSD) for surveys by calculating the success rates and accuracy of volume estimates of individuals at different elevations. We establish an optimal GSD of 0.8 cm px^{-1} for animals similar in size to UK grey seals (~1.4-2.5 m length), making our pipeline reproducible and applicable to a broad range of organisms. Volume estimates were accurate and could be made for up to 68% of hauled-out seals in the study areas. Finally, we highlight six key traits that make a species well-suited to estimating body volume following this pipeline. Good candidates include large reptiles like crocodiles, large mammals such as hippopotamus, and shrubs or bushes in deserts and Mediterranean habitats. Our pipeline accurately estimates individual body volume of marine macrovertebrates in a time-and cost-effective manner whilst minimising disturbance. Whilst the approach is applied to pinnipeds here, the pipeline is adaptable to many different taxa that are otherwise challenging to study. Our proposed approach therefore opens up previously inaccessible areas of the Tree of Life to demographic studies, which will improve our ability to protect and conserve these species into the future.

Philip, L. (2023). Crocodiles: facts, myths, and symbolism in Africa. National Museum Publications (https://nationalmuseumpublications.co.za/crocodiles-facts-myths-and-symbolism-in-africa/).

Taylor, Z., English, C., Cramberg, M. and Young, B.A. (2023). The influence of spinal venous blood pressure on cerebrospinal fluid pressure. Scientific Reports 13(1) (doi: 10.1038/s41598-023-48334-8).

Abstract: In *Alligator mississippiensis* the spinal dura is surrounded by a venous sinus; pressure waves can propagate in the spinal venous blood, and these spinal venous pressures can be transmitted to the spinal cerebrospinal fluid (CSF). This study was designed to explore pressure transfer between the spinal venous blood and the spinal CSF. At rest the cardiac-related CSF pulsations are attenuated and delayed, while the ventilatory-related pulsations are amplified as they move from the spinal venous blood to the spinal CSF. Orthostatic gradients resulted in significant alterations of both cardiac- and ventilatory-related CSF pulsations. Manual lateral oscillations of the alligator's tail created pressure waves in the spinal CSF that propagated, with slight attenuation but no delay, to the cranial CSF. Oscillatory pressure pulsations in the spinal CSF and venous blood had little influence on the underlying ventilatory pulsations, though the same oscillatory pulsations reduced the ventilatory- and increased the cardiac-related pulsations in the cranial CSF. In *Alligator* the spinal venous anatomy creates a more complex pressure relationship between the venous and CSF systems than has been described in humans.

Parks, A.J., Godfrey, S.T., Gross, B.A., Balaguera-Reina, S.A., Smith, N.G., Mazzotti, F.J. and Densmore III, L.D. (2023). Not one but two: examining the genetic origin and characterization of the non-native spectacled caiman (*Caiman crocodilus*) in Florida. Biological Invasions (https://doi.org/10.1007/s10530-023-03207-z).

Abstract: The US state of Florida is home to an alarmingly large number of invasive species, many of which have proven detrimental to native ecosystems. Biological invasions of reptiles in particular have been a major concern in recent years. The spectacled caiman (*Caiman crocodilus*) was first introduced from Latin America to Florida in the 1950s. Given there are now established breeding populations across southern Florida, there are ongoing efforts to control them. Therefore, there is a need to understand this species' natural history and introduction pathways. Previous studies have cited the Caribbean Coastal region of Colombia as a primary, and possibly exclusive, origin of *C. crocodilus* in Florida, and the species was identified as belonging to the *C. c. fuscus* molecular lineage. However, previous genetic sampling has been limited and may have been biased by small sample sizes and limited geographic scale. We collected 27 genetic samples from caimans captured in Florida, and sequenced the mitochondrial genes, Cytochrome oxidase I (COI) and Cytochrome B (CytB) for comparison with homologous gene fragments available for the species at GenBank. We found genetic evidence for multiple introduction events and the taxonomic classification of the Florida caimans as two distinct molecular lineages (*C. c. fuscus* and *C. c. crocodilus*) originating from at least two different regions: the Magdalena River Basin in Colombia and the Upper Branco River Basin in northern Brazil. This study helps to elucidate the genetic history of Florida caimans and provides valuable insight for population management of the species in Florida.

Kononova, Y., Adamenko, L., Kazachkova, E., Solomatina, M., Romanenko, S., Proskuryakova, A., Utkin, Y., Gulyaeva, M., Spirina, A., Kazachinskaia, E., Palyanova, N., Mishchenko, O., Chepurnov, A. and Shestopalov, A. (2023). Features of SARS-CoV-2 replication in various types of reptilian and fish cell cultures. Viruses 15: 2350.

Abstract: SARS-CoV-2 can enter the environment from the feces of COVID-19 patients and virus carriers through untreated sewage. The virus has shown the ability to adapt to a wide range of hosts, so the question of the possible involvement of aquafauna and animals of coastal ecosystems in maintaining its circulation remains open. The aim of this work was to study the tropism of SARS-CoV-2 for cells of freshwater fish and reptiles, including those associated with aquatic and coastal ecosystems, and the effect of ambient temperature on this process. In a continuous cell culture FHM (fathead minnow) and diploid fibroblasts CGIB (silver carp), SARS-CoV-2 replication was not maintained at either 25°C or 29°C. At 29°C, the continuous cell culture TH-1 (eastern box turtle) showed high susceptibility to SARS-CoV-2, comparable to Vero E6 (development of virus-induced cytopathic effect (CPE) and an infectious titer of 7.5 ± 0.17 $\log_{10}$ $TCID_{50}$/mL on day 3 after infection), and primary fibroblasts CNI (Nile crocodile embryo) showed moderate susceptibility (no CPE, infectious titer 4.52 ± 0.14 $\log_{10}$ $TCID_{50}$/mL on day 5 after infection). At 25°C, SARS-CoV-2 infection did not develop in TH-1 and CNI. Our results show the ability of SARS-CoV-2 to effectively replicate without adaptation in the cells of certain reptile species when the ambient temperature rises.

Arias, A.A. (2023). Muscle function during terrestrial locomotion in alligators. UC Irvine. ProQuest ID: Arias_uci_0030D_18592. Merritt ID: ark:/13030/m5nq352m. Retrieved from https://escholarship.org/uc/item/00h8k499.

Abstract: Most legged animals have evolved a suite of musculoskeletal adaptations to reduce the energetic cost of locomotion (e.g. upright limb posture, long tendons), but it remains unclear whether alligators and other sprawlers are capable of using similar energy saving mechanisms during locomotion. Through a combination of *in situ* muscle preparations, joint-level analyses, and *in vivo* muscle function measurements during walking we show that 1) alligator limb joint mechanics are similar to other legged animals during walking, 2) a representative ankle extensor, the gastrocnemius externus, is capable of storing significant elastic energy in its tendon during supramaximal contractions, 3) *in vivo* muscle work during locomotion is surprisingly low, suggesting tendon does significant work during locomotion, and 4) alligators modulate limb and limb muscle function to improve stability or work generation when walking across non-level terrain. This work adds to the body of work on muscle function during legged locomotion and shows that

general strategies and energy saving mechanisms (eg elastic energy storage) during legged locomotion are likely more widespread than previously assumed.

Lange, J.A., Rittgers, A.L. and Davis, A. (2023). Brown anole (*Anolis sagrei*) Hoxa5: Insights into the divergence of Hoxa5 gene expression and regulation across evolutionarily divergent gnathostome vertebrates. Georgia Journal of Science 81(2): Article 14.

Abstract: Hox genes are evolutionarily conserved developmental regulatory genes that function, in part, to pattern the anterior-posterior (AP) axis of organs and organ systems during animal embryonic development. Hoxa5, specifically, is shown to be expressed in the spinal cord, somites, or transient compartments giving rise to the vertebrae and ribs, developing gut, lungs, and limbs of the mouse (*Mus musculus*). The cis-regulatory elements (CREs), or short DNA sequences, that direct Hoxa5 expression in these embryonic domains have been mapped and functionally tested in the mouse as well. Similar Hoxa5 expression patterns have been observed in chicken (*Gallus gallus*), American alligator (*Alligator mississipiensis*), and dogfish shark (*Scyliorhinus canicular*), but have shown divergence in the anterior limit of expression within the somites. Specifically, while mouse expression begins in somite 3, chicken, alligator, and shark begin in 8, 9, and 9, respectively. Further, no hoxa5 expression has been observed in the somites for teleost fish. Here, we present the embryonic Hoxa5 expression pattern within brown anole lizard (*Anolis sagrei*). Our data shows that Hoxa5 within the lizard has an anterior limit of expression in somite 6 and exhibits a more similar expression pattern to that of mouse, chicken, alligator, and shark than to teleost fishes. Furthermore, our comparative genomic DNA sequence analyses display that the functional CREs mapped in the mouse are conserved among the tetrapods, but not with the shark or teleost fishes. Our analyses suggest that divergent Hoxa5 expression patterns result from divergence within their respective CREs.

Balaguera-Reina, S.A., Brandt, L.A., Hernandez, N.D., Mason, B.M., Smith, C.D. and Mazzotti , F.J. (2023). Body condition as a descriptor of American alligator (*Alligator mississippiensis*) health status in the Greater Everglades, Florida, United States. PLoS One 18(11): e0295357.

Abstract: Body condition is used as an indicator of the degree of body fat in an animal but evidence of its actual relationship with health diagnostics (eg blood parameters) is usually lacking across species. In American alligators (*Alligator mississippiensis*), body condition has been used as a performance metric within the Greater Everglades ecosystem to provide insight on hydrological and landscape changes on alligator populations. However, there is no clear evidence that spatial body condition changes relate to different health conditions (low food intake vs sickness) and whether this link can be made when relating body condition values with blood parameters. We assessed the relationship between alligator body condition and 36 hematological and biochemistry (blood) parameters in four areas across two physiographic regions (Everglades and Big Cypress) of the Greater Everglades (sample size= 120). We found very strong to weak evidence of linearity between 7 (Big Cypress) and 19 (Everglades) blood parameters and relative condition factor index, from which cholesterol (38%) and uric acid (41%) for the former and phosphorus (up to 52%) and cholesterol (up to 45%) for the latter (mean absolute error MAE= 0.18 each) were the predictors that individually explain most of the body condition variation. The best combination of blood parameters for the Everglades were cholesterol, phosphorus, osmolality, total protein, albumin, alpha 2, beta, and gamma globulins, and corticosterone accounting for 40% (37 ± 21%, MAE= 0.16) of the variation found in alligator body condition for this region. We found better predictability power in models when analyzed at smaller rather than larger scales showing a potential habitat effect on the body condition-blood parameters relationship. Overall, Everglades alligators in poorer condition are likely dehydrated or have an inadequate diet and the spatial differences found between physiographic regions suggest that these areas differ in prey availability/quality.

Jensen, T.R., Anikin, A., Osvath, M. and Reber, S.A. (2024). Knowing a fellow by their bellow: acoustic individuality in the bellows of the American alligator. Animal Behaviour 207: 157-167.

Abstract: Identity cues in animal calls are essential for conspecific vocal individual recognition. Some acoustically active species mainly show reliable identity cues in their vocalizations because of variation in anatomy and life history. Long and strenuous-to-produce vocalizations may be particularly effective for showing identity cues because sustaining such calls may reveal individual anatomical differences in sound production. It is largely unknown whether reptiles possess acoustic individuality despite some groups being vocal. We analysed 814 bellows from 47 American alligators, *Alligator mississippiensis*, extracting spectral characteristics and manually corrected contours of the fundamental frequency. Recognition was up to 66% correct with a supervised classifier (random forest) and 61% with unsupervised clustering (chance= 2.1%), indicating that individual alligators have highly distinct bellows. Alligators were distinguished primarily based on the call spectrum, fundamental frequency contour and amplitude modulation, which also provided information about the animal's size. Neither manual supervision of acoustic analyses nor supervised training on labelled data was necessary to achieve reasonable accuracy, which has promising potential for identification of individuals via passive acoustic monitoring for research and conservation purposes. Additionally, our results highlight the importance of studying the utilization of acoustic individuality in the social lives of crocodylians.

Clemente, G.R.C., Gutierrez-Liberato, G.A., Anjos, C.C., Simões, P.I., Mudrek, J.R., Fecchio, A., Lima, J.H.A., Oliveira, P.M.A., Pinho, J.B., Mathias, B.S., Guimarães, L.O. and Kirchgatter, K. (2023). Occurrence of hepatozoon in some reptiles from Brazilian biomes with molecular and morphological characterization of *Hepatozoon caimani*. Diversity 15: 1192.

Abstract: Amphibians and reptiles represent a considerable proportion of the vertebrate fauna in Brazil. Different blood parasitic infections have been reported in these groups, such as *Haemogregarina*, *Hepatozoon*, *Trypanosoma* and microfilariae. However, insufficient research on interactions between these parasites and their hosts has been carried out in some regions of the country. Samples were collected from populations of wild herpetofauna in different microhabitats throughout Brazil, totaling 111 samples of reptiles from the states of Mato Grosso and Pernambuco. We used an integrative approach, with classical microscopy, morphometry and molecular analysis, in order to identify hemoparasites present in the analyzed fauna. Genomic DNA was extracted for the PCR protocol based on the 18S ribosomal RNA gene for Hepatozoon spp. A total of 53 positives were obtained with molecular screening (47.7%), all confirmed as *Hepatozoon* spp. using DNA sequencing. Among positive samples, 23 slides were examined, confirming the presence of *Hepatozoon* spp. in 91.3% of the smears. The phylogenetic analysis performed with sequences from 43 samples resulted in a tree containing several distinct clades. Sequences were generally grouped according to the taxonomic order of the host. Co-infections with microfilariae and *Trypanosoma* spp. were also found in microscopy analyses. This study describes the presence of *Hepatozoon caimani* in a new host species (*Paleosuchus palpebrosus*) that can be a paratenic host in the natural environment. The existence of parasitic co-infections in alligator species underscores the significance of recognizing the impact of infections by various parasitic taxa on the host populations.

Turko, A.J., Firth, B.L., Craig, P.M., Eliason, E.J., Raby, G.D. and Borowiec, B.G. (2023). Physiological differences between wild and

captive animals: a century-old dilemma. Journal of Experimental Biology 226(23) (https://doi.org/10.1242/jeb.246037).

Abstract: Laboratory-based research dominates the fields of comparative physiology and biomechanics. The power of lab work has long been recognized by experimental biologists. For example, in 1932, Georgy Gause published an influential paper in Journal of Experimental Biology describing a series of clever lab experiments that provided the first empirical test of competitive exclusion theory, laying the foundation for a field that remains active today. At the time, Gause wrestled with the dilemma of conducting experiments in the lab or the field, ultimately deciding that progress could be best achieved by taking advantage of the high level of control offered by lab experiments. However, physiological experiments often yield different, and even contradictory, results when conducted in lab versus field settings. This is especially concerning in the Anthropocene, as standard laboratory techniques are increasingly relied upon to predict how wild animals will respond to environmental disturbances to inform decisions in conservation and management. In this Commentary, we discuss several hypothesized mechanisms that could explain disparities between experimental biology in the lab and in the field. We propose strategies for understanding why these differences occur and how we can use these results to improve our understanding of the physiology of wild animals. Nearly a century beyond Gause's work, we still know remarkably little about what makes captive animals different from wild ones. Discovering these mechanisms should be an important goal for experimental biologists in the future.

LePore, C.N. (2023). After awhile ... crocodile?: An assessment of crocodylians as living fossils. Proceedings of the International Conference on Creationism 9: Article 32.

Abstract: Crocodylians, which include extant crocodiles, alligators, caimans, the gharial, and the tomistoma, are often considered living fossils. Many evolutionists have argued that the term 'living fossil' is inappropriately applied to crocodylians, since past diversity within Crocodylia, as well as within the more inclusive group Crocodylomorpha, implies that they have evolved substantially since their first appearance in the fossil record. In contrast, many creationists argue that the morphological conservativeness of living fossils like crocodylians is unexpected from a gradualistic model of evolution. To clarify this issue, we argue that while the term 'living fossil' has varied meanings within the literature, morphological conservativism is a key aspect of the living fossil concept. From the fossil record, it is clear that some extinct crocodylomorphs have bauplans that differ greatly from that of extant crocodylians. These include fully marine forms with flippers and a caudal fin and fully terrestrial forms including herbivores, carnivores with theropod-like teeth, and even forms with mammal-like teeth. Nevertheless, all extant and most extinct fossil crocodylians have a similar bauplan, being quadrupedal, semi-aquatic predators. The fossil range of Crocodylia extends from the Upper Cretaceous to the present. When forms that are very "crocodylian-like" (eg goniopholidids) are included, this range is extended into the Jurassic. Morphological conservativeness is a relative term, but by any standard, the crocodylian or "crocodylian-like" bauplan is surprisingly conservative morphologically, especially given the immense amount of time assigned to these intervals by conventional geologists, the massive global environmental perturbations that are thought to have occurred during this time, and the large-scale changes that must have occurred - from an evolutionary perspective - in other lineages (eg mammals) during that same time. Thus, we argue that it remains appropriate to consider crocodylians 'living fossils.' Evolutionists need to grapple with the lack of substantial morphological change in the crocodylian lineage since the Mesozoic. At the same time, creationists need to be careful to not overemphasize the degree of morphological stasis in certain examples of living fossils when using them to argue against aspects of evolutionary theory.

Gurung, S. (2023). Habitat Use by Gharial and Mugger Crocodile in Rapti River, Chitwan National Park, Nepal. MSc thesis, Tribhuvan University, Kathmandu, Nepal.

Abstract: In Nepal, two crocodilians, Mugger (*Crocodylus palustris*) and Gharial (*Gavialis gangeticus*), share a sympatric range in the Rapti River in Chitwan National Park. To better understand the influence of different habitat characteristics on the distribution of these crocodiles and aid in their conservation, a study was conducted between February and March 2023. The study collected data along the river, focusing on habitat characteristics at 500-m intervals and areas where both species were observed. Generalized Linear Model with binary logistic regression was used for statistical analysis. This model helped to examine the presence or absence of Mugger and Gharial at different sampling points, using seven habitat characteristics as predictors. These predictors included the slope and aspect of the river bank, distance to the forest and human settlements, level of human disturbances, water current, and river bank substrate type. The statistical significance of these predictors was assessed using the likelihood ratio test, and the probability of crocodile sightings in relation to habitat variables was determined using the Akaike Information Criterion. The results of the analysis showed that human disturbances and water currents were significant factors influencing the presence of Gharials. On the other hand, only the slope of the river bank was found to be a significant factor in the presence of Muggers at specific sampling stations. These findings highlight that Gharials and Muggers have distinct habitat preferences, emphasizing the importance of effective habitat management by the concerned authorities. The study underscores the necessity of considering these influential factors in conservation efforts aimed at protecting the Mugger and Gharial species in the Rapti River. By understanding their specific habitat requirements and promoting suitable coexistence, conservationists can contribute to the effective conservation of these crocodilians.

Basu, S.K., Das, S. and Cetzal-Ix, W. (2023). Indian Saltwater crocodiles (*Crocodylus porosus* Schneider, 1801) and their conservation perspective. Annales Universitatis Paedagogicae Cracoviensis Studia Naturae 8 (doi: 10.24917/25438832.8.x).

Abstract: The Saltwater crocodile (*Crocodylus porosus* Schneider, 1801), population in India has been relatively stable. They are listed as a Schedule I species in the Wildlife Protection Act of India, which provides them with legal protection. However, several natural and anthropogenic factors are cumulatively putting significant challenges towards the successful conservation of the various populations and sub-populations of the Saltwater crocodiles in their natural habitats across India. Hence, it is important to understand the factors impacting their population decline and identifying the strategies and policies necessary for successful long term conservation of this majestic reptilian species across their natural habitats in India. The current study makes a multi perspective introspection of the successful conservation efforts of the Indian Saltwater crocodile.

Rahman, M.L.A., Balakrishnan, P.A.P., Veeramuthu, S.A.L.P. and Rahman, N.S.A. (2023). Tales of crocodiles from Nusantara: The sacred stories of the river folklore. Asian Social Science 19(6): 136-136.

Abstract: This paper explores the menacing reputation of reptiles in oral traditions and focuses on famous crocodile-related stories in Malaysia and neighbouring regions. It aims to analyze these tales from a sacred perspective, as beliefs about these creatures impact communities. The paper addresses how these narratives influence people's perceptions and beliefs about crocodiles. Data is sourced from specialized websites, and sacred concepts introduced by scholars are applied to analyze the stories. This research delves into the cultural significance of these stories, shedding light on their role in shaping attitudes towards these formidable reptiles.

Melo, K., Horvat, T. and Ijspeert, A.J. (2023). Animal robots in the African wilderness: Lessons learned and outlook for field robotics. Sci Robot 8(85) (doi: 10.1126/scirobotics.add8662).

Abstract: In early 2016, we had the opportunity to test a pair of sprawling posture robots, one designed to mimic a crocodile and another designed to mimic a monitor lizard, along the banks of the Nile River in Uganda, Africa. These robots were developed uniquely for a documentary by the BBC called Spy in the Wild and fell at the intersection of our interests in developing robots to study animals and robots for disaster response and other missions in challenging environments. The documentary required that these robots not only walk and swim in the same harsh, natural environments as the animals that they were modeled on and film up close but also move and even look exactly like the real animals from an aesthetic perspective. This pushed us to take a fundamentally different approach to the design and building of biorobots compared with our typical laboratory-residing robots, in addition to collaborating with sculpting artists to enhance our robots' aesthetics. The robots needed to be designed on the basis of a systematic study of data on the model specimens, be fabricated rapidly, and be reliable and robust enough to handle what the wild would throw at them. Here, we share the research efforts of this collaboration, the design specifications of the robots' hardware and software, the lessons learned from testing these robots in the field first hand, and how the eye-opening experience shaped our subsequent work on disaster response robotics and biorobotics for challenging amphibious scenarios.

Payne, A.R., Mannion, P.D., Lloyd, G.T. and Davis, K.E. (2023). Decoupling speciation and extinction reveals both abiotic and biotic drivers shaped 250 million years of diversity in crocodile-line archosaurs. Nature Ecology & Evolution (doi: 10.1038/s41559-023-02244-0).

Abstract: Whereas living representatives of Pseudosuchia, crocodylians, number fewer than 30 species, more than 700 pseudosuchian species are known from their 250-million-year fossil record, displaying far greater ecomorphological diversity than their extant counterparts. With a new time-calibrated tree of >500 species, we use a phylogenetic framework to reveal that pseudosuchian evolutionary history and diversification dynamics were directly shaped by the interplay of abiotic and biotic processes over hundreds of millions of years, supported by information theory analyses. Speciation, but not extinction, is correlated with higher temperatures in terrestrial and marine lineages, with high sea level associated with heightened extinction in non-marine taxa. Low lineage diversity and increased speciation in non-marine species is consistent with opportunities for niche-filling, whereas increased competition may have led to elevated extinction rates. In marine lineages, competition via increased lineage diversity appears to have driven both speciation and extinction. Decoupling speciation and extinction, in combination with ecological partitioning, reveals a more complex picture of pseudosuchian evolution than previously understood. As the number of species threatened with extinction by anthropogenic climate change continues to rise, the fossil record provides a unique window into the drivers that led to clade success and those that may ultimately lead to extinction.

Than, K.Z., Zaw, Z., Quan, R-C. and Hughes, A.C. (2024). Biodiversity conservation in Myanmar's coastal wetlands: Focusing on saltwater crocodile habitats and connectivity. Biological Conservation 289 (https://doi.org/10.1016/j.biocon.2023.110396).

Abstract: Landscape-level conservation strategies are needed to protect the saltwater crocodile population and habitats in Myanmar. Identifying the remaining habitats and movement corridors is essential due to population decline across coastal regions and insufficient habitat coverage, even within protected areas. This study predicts the distribution of habitats and creates low-resistance corridors that facilitate movement across the landscape. Occurrence dataset encompassing a 20-year period (1999-2019) was used incorporating records gathered from the Global Biodiversity Information Facility-GBIF, crocodile counting reports from the Meinmahla Kyun wildlife sanctuary of Myanmar, and recent spotlight and camera-trap surveys. Using landscape connectivity tools, structural compositions of habitat classes were determined, and habitat patches were delineated to simulate the least-cost corridor and dispersal pathways. Two patches in Rakhine, two in Ayeyarwady and Yangon, one in Mon, and two in Tanintharyi, were identified that include 1247 km^2 of core suitable habitat areas. The Ayeyarwady Delta exhibits a plethora of suitable habitats, while the Rakhine and Tanintharyi regions have higher marginal habitats that are largely unprotected. Only 12% of the extent of occurrence of saltwater crocodiles are suitable habitats with a high potential for occupancy. Habitats are highly fragmented and four bottlenecks are identified to assist population connectivity in those fragmented patches. Despite notable challenges in ensuring connectivity to restore populations across the habitat patches, we highlighted connectivity as the foundation for establishing an ecological network of Myanmar's coastal habitats, leveraging the saltwater crocodile as an umbrella species for the region's coastal wetlands, and identifying key areas for enhanced protection.

Hans-Volker, K., Tichy, G. and Safi, A. (2023). A reassessment of the geochemical, phylogeny, morphology, and taxonomy of two crocodilian jaw remains of Paleogene from central Europe (Germany and Austria). International Journal of Biological Research 10(3): 1-7.

Abstract: Crocodiles are a conservative group of reptiles regarding their morphology and behaviour. Available Fossils are hence important to be studied for phylogeny, taxonomy and morphology. A fossil fragmentary crocodilian skull was found in lignite clay in the Paleogene sedimentary area from the Middle Oligocene Epoch of Sieglitz near Camburg at Saale river in Central Germany. This 20th century discovery documents a new species of *Diplocynodon* (*Diplocynodon haeckeli*, described by Seidlitz in 1917). Another crocodile fossil was unearthed in 1878 from the Eocene Epoch, of Haunsberg near Sankt Pankraz in the province of Salzburg in Austria, which had been missing since 1970 and was recently rediscovered and identified. This rediscovered specimen, representing a crocodile mandible and an isolated tooth, which could belong to *Asiatosuchus* and not *Diplocynodon*. However, the morphology of isolated tooth is not a reliable source to identify it up to the generic level, so open taxonomy is used here for identification, it may be associated to the same or a new species. The new discoveries of fossils provide new characters enhancing our knowledge on a particular taxon and on the whole group.

Whitaker, N. (2023). Studies on the Marsh (Mugger) crocodile (*Crocodylus palustris*) on the Cauvery River in Tamil Nadu. Pp. 47-56 *in* Proceedings of the 2nd Annual Research Conference, ed. by A. Udhayan, Nihar Ranjan, M.G. Ganesan, A. Manimozhi, K. Sankar, A. Pradeep, D. Vasanthakumari, M. Gabriel Paulraj and T.T. Shameer. Tamil Nadu Forest Department: Vandalur, Chennai.

Abstract: Between 2018 and 2020, the Cauvery River in the Delta Region, Tamil Nadu, was studied concerning population, spatial patterns of movement, and education programs to mitigate conflict between people and crocodiles. The Project began with direct and indirect sightings of crocodiles, namely in the area of Anakarai town and, to a lesser degree, the Vakaramarri tank near Chidambaram. It was quickly realized that a large breeding population is present at Anakarai Dam and its environs based on the evidence of hatchlings. It was therefore decided to use this location for radio tagging (two males and three females). Capture occurred in June 2019, and crocodiles were released with no untoward effects at the exact location they were caught at. Human crocodile-interaction on the Cauvery River is a contentious problem which needs to be addressed early.

Honegger, R.E. (2023). Alligators in the circus ring - an unusual habitat for an American icon. Bibliotheca Herpetologica 17(13): 131-136.

Honneger, R.E. (2023). Vom Drachen zum Krokodil - Ein illustriertes Feuilleton - Anmerkungen zu frühen Krokodilen in einigen nicht englischsprachigen Teilen Europas - (Teil I). Sekretär 23(2): 52-74.

[From dragon to crocodile - an illustrated feature article - Notes on early crocodiles in some non-English languages Sharing Europe – (Part I)]

Summary: Although recent crocodiles have never played a role in Europe, they are of historical importance. The following vignettes are intended to illustrate some of them. This essay is not about presenting illustrations of the first descriptions of crocodiles, but I would like to show the contemporary handling of the strange creature crocodile. The importance of the Nile Crocodiles in the history of ancient Egypt and in the Napoleonic campaigns to Egypt are expressly excluded here. On the one hand, they personified evil, the beast that had to be slain or stabbed. on the other hand, the crocodiles became souvenirs for pilgrims, adventurers and emigrants and are thus directly related to the colonization of foreign countries. in sacred buildings, dried crocodile skins or stuffed crocodiles were displayed in a visible place as a symbol of evil or hung on chains from the ceiling. in cabinets of wonder or nature [Wunderkammern], the crocodiles also had a positive influence on natural science. at fairs, stuffed or live crocodiles satisfied our ancestors' desire to see exotic creatures. With the beginning of scheduled ship traffic, an increasing number of strange, unknown reptiles started to arrive at the ports of London, Amsterdam and later Hamburg. There animal dealers started to offer their exotics to private persons, zoological gardens and menageries. This article is also intended to show, with all due respect, that the crocodiles *per se* are not bloodthirsty beasts that are to be destroyed by any means possible.

Amanya, S. (2023). Conservation and Management of the Nile crocodile "*Crocodylus niloticus*" in Uganda, a case study of Lake Victoria and Victoria Nile River at Murchison Falls National Park. MSc thesis, Universidad Internacional de Andalucía, Spain.

Abstract: The study focused on the conservation and management of *C. nilotus* in Uganda, in one protected habitat Murchison Falls National, and non-protected Lake Victoria. The study aimed at determining the *C. niloticus* population status, nature and extent of human-crocodile conflict and challenges facing the ranching program regulated by CITES. During the study, day and night spotlight counts were carried out in both habitats, as well as a survey of human-crocodile conflict targeting the victims and residents. Local communities were interviewed to obtain indigenous knowledge on *C. niloticus* conservation and management. Key informant interviews were conducted with authorities and the ranching company. Spotlight survey revealed 1102 crocodiles in Murchison Falls National Park in a ratio of 1.5:1:2.5 for juveniles, sub-adults and adults, respectively. Also, 210 *C. niloticus* from Lake Victoria were estimated from direct observations collaborated with community interviews. There were 310 human crocodile attacks recorded from around L. Victoria and 32 incidents from the MFNP. The significant factors that collaborated in this conflict were ethnicity, age, sex, marital status, education, and water-based livelihood activities such as fishing and fetching water for domestic use. Ranching is largely affected by limited eggs and technology to increase outputs. The results of this study point to the need to increase capture and conversion of problem crocodiles to breeding stock for eggs to support ranching, as well as ensure continuous species monitoring. Uganda mahy with CITES provisions if there is continuous monitoring and reporting on all aspects of crocodile ranching as provided under Resolution Conf. 11.16.

Bio Ouré, R., Kpéra, G.N., Kassa, B., Djagoun, C.A.M.S., Natta, A., Djego, J.G., Eniang, E.A., Mensah, G.A. and Sinsin, B. (2023). Does crocodile conservation matter in sacred natural sites of Benin (Western Africa)? West African Journal of Applied Ecology 31(2): 69-85.

Abstract: Crocodiles are protected species present in Sacred Natural Sites (SNS) in Benin.The impact of SNSs on the conservation of crocodylians in Benin were carried out by (i) assessing the extent to which anthropogenic activities affect crocodylians' population, and (ii) analysing the impact of social and religious changes for the conservation of crocodylians over a timescale. The characteristics of the crocodile population and habitats in 11 SNSs during daytime and night were also provided. Semi-structured interviews with 330 respondents were conducted and land use/land cover changes with 2000 and 2020 remote sensing data were analysed. The West Africa crocodile (*Crocodylus suchus*) was recorded in 81.8% SNS and consisted of 61.5% hatchlings, 15.6% juveniles, 11.85% subadults, and 11.1% adults (N= 135 crocodiles). With increasing degradation of natural ecosystems and increasing settlements/ agricultural lands, there has been a significant decrease in crocodile abundance and extirpation (18.2% SNSs). Communities perceived crocodiles as sacred, a link with ancestors, the god of fertility, and a way to preserve water. Nevertheless, respondents also perceived the negative impact of introduced religions (70.9%) and no longer worshiped sacred crocodiles (52.7%) due to religious prohibition. Raising awareness, and participatory management of SNSs with the communities would help to mitigate the threats.

Durán-Apuy, A., Mora, J.M., Chavarría-Trejos, R. and Madrigal-Vargas, A. (2023). An index to assess the level of vulnerability to crocodiles in coastal communities. Phyllomedusa 22(2): 99-119.

Abstract: An index to assess the level of vulnerability to crocodiles in coastal communities. Human-wildlife negative interactions are a recurring phenomenon worldwide, originating from the shared habitats and resources between both. In several coastal communities, negative interactions occur due to the presence of the American Crocodile (*Crocodylus acutus*). We have developed an index to assess the level of vulnerability of communities to this reptile. The construction of this index is based on the Approximate Sustainability Index developed by Gutiérrez-Espeleta in 1994. The Index of Vulnerability (IVU) is built upon several indicators across four parameters: social, biological-environmental, institutional, and spatial. These indicators are assessed using a performance scale and interpretation. The IVU assigns values to the vulnerability condition, which are presented in a color scale corresponding to defined intervals. For each indicator, reference categories and rating scales are represented with traffic light colors and numerical ratings. The IVU value obtained for a community can be visualized with a map and a corresponding figure, including a table of values for the assessed parameters.

Pereyra, M.E., Cerroni, M.A., Lecuona, A., Bona, P., Fernández Dumont, M.L. and Otero, A. (2023). Hindlimb and pelvic anatomy of *Caiman yacare* (Archosauria, Pseudosuchia): Myology and osteological correlates with emphasis on lower leg and autopodial musculature. Journal of Anatomy (doi: 10.1111/joa.13995).

Abstract: The anatomy of the archosaurian pelvis and hindlimb has adopted a diversity of successful configurations allowing a wide range of postures during the evolution of the group (eg erect, sprawling). For this reason, thorough studies of the structure and function of the pelvic and hindlimb musculature of crocodylians are required and provide the possibility to expand their implications for the evolution of archosaurian locomotion, as well as to identify potential new characters based on muscles and their bony correlates. In this study, we give a detailed description of the pelvic and hindlimb musculature of the South American alligator *Caiman yacare*, providing comprehensive novel information

regarding lower limb and autopodial muscles. Particularly for the pedal muscles, we propose a new classification for the dorsal and ventral muscles of the autopodium based on the organisation of these muscles in successive layers. We have studied the myology in a global background in which we have compared the *Ca. yacare* musculature with other crocodylians. In this sense, differences in the arrangement of m. flexor tibialis internus 1, m. flexor tibialis externus, m. iliofibularis, mm. puboischiofemorales internii 1 and 2, between *Ca. yacare* and other crocodylians were found. We also discuss the muscle attachments that have different bony correlates among the crocodylian species and their morphological variation. Most of the correlates did not exhibit great variation among the species compared. The majority of the recognised correlates were identified in the pelvic girdle; additionally, some bony correlates associated with the pedal muscles are highlighted here for the first time. This research provides a wide framework for future studies on comparative anatomy and functional morphology, which could contribute to improving the character definition used in phylogenetic analyses and to understand the patterns of musculoskeletal hindlimb evolution.

Greco, Jr., R.M., Brocca, J., Tellez, C.M., Espinal, R.J., Peña, J.E., Peña Perez, R., Serra, C., Beckley, S. and Rosenblatt, A.E. (2023). Population Status of American Crocodiles (*Crocodylus acutus*) in the Dominican Republic. Journal of Herpetology 57 (4): 418-427.

Abstract: Crocodilian populations declined globally during the 20th century because of overhunting and habitat loss. Some crocodilian populations recovered over the past 50 yr through legal protections and habitat restoration, but the statuses of many populations are poorly known. The status of the American Crocodile (*Crocodylus acutus*) population in the Dominican Republic (DR) is currently unknown because the last countrywide surveys were done in the 1980s. We carried out population surveys in DR during May-July 2021 in areas where *C. acutus* has been observed historically to provide an updated population status. Our surveys yielded no crocodile sightings in northwestern DR, suggesting that crocodiles have been extirpated or nearly extirpated from this area. Our surveys of Lago Enriquillo in southwestern DR produced 120 crocodile sightings over 72.6 km of shoreline, for an overall encounter rate of 1.65 crocodiles/km and nonhatchling encounter rate of 1.40 crocodiles/km. Encounter rates were very high in the main nursery area of the lake (La Azufrada; 60.0 crocodiles/km) and much lower elsewhere. Our *C. acutus* sightings were composed of 18 (15%) hatchlings, 45 (37.5%) juveniles, 12 (10%) subadults, and 32 (26.7%) adults, and we were unable to estimate size for 13 (10.8%) individuals. During 2021 nest surveys, we only located 42 nests in Lago Enriquillo. Our data suggest the DR population of *C. acutus* is critically endangered and is continuing to decline because of pressure from hunting, fishing, and habitat destruction caused by both anthropogenic factors and natural lake level fluctuations.

Swords, A., Cramberg, M., Parker, S., Scott, A., Sopko, S., Taylor, E. and Young, B.A. (2023). Alligatorascension: climbing performance of *Alligator mississippiensis*. Amphibia-Reptilia (doi: https://doi.org/10.1163/15685381-bja10165).

Abstract: In tetrapedal locomotion, whether horizontal or during climbing, interactions between the foot and the contact surface or substrate influence the locomotor performance. Multiple previous studies of tetrapedal squamates (lizards) have reported that the animals used the same locomotor velocity, regardless of the angle of ascension. The present study was performed to determine if the American alligator (*Alligator mississippiensis*) would exhibit a stable climbing velocity and to determine to what degree, if any, this climbing velocity could be modified by substrate differences. Sub-adult *Alligator mississippiensis*, with body lengths around 170 cm, used the same stride velocity when moving at angles of 0°, 30°, and 55°. During these trials, both the sub-adult and juvenile alligators used a "low walk" gait, rather than a distinctive climbing gait. When the alligators traversed an open grate, their stride duration increased (and stride velocity decreased) presumably due to the insertion (and retraction) of their claws and digits into the grate. When climbing at 55° the juvenile and sub-adult alligators used the same stride duration; the sub-adults used a stride length that was significantly larger in absolute terms, but significantly shorter in relative terms. Despite their large size, and their more caudal center of mass, the climbing performance of *Alligator mississippiensis* is similar to what has been described in the previously-studied tetrapedal squamates.

Viotto, E.V., Leiva, P.M.L., Pierini, S.E., Simoncini, M.S., Navarro, J.L. and Piña, C.I. (2024). Body condition of reproductive and non-reproductive Broad-snouted caiman females. Animals 14: 1 (https://doi.org/10.3390/ani14010001).

Abstract: In this work, we calculated the body condition indices, K-Fulton and scaled mass index (SMI), of reproductive and non-reproductive Caiman latirostris adult females as an indication of stored energy. We considered 87 adult females captured from 2001 to 2018, both reproductive and non-reproductive. The body condition was calculated considering two scenarios: (a) only the weight of the female, and (b) the sum of the weight of the female and the average dry weight of her nest. We tested the difference in body condition between reproductive and non-reproductive females. We also evaluated the minimal body condition required to guarantee that females above it are reproductive by drawing a line that separated the body condition of strictly reproductive individuals from those that may or may not be reproductive. Reproductive females had better body condition than non-reproductive ones. Our SMI.S line separated almost 70% of the reproductive females. Based on our results, we can guarantee that a female whose body condition is above the line will reproduce, although not all those females below the line are non-reproductive, as a few of those under the line will nest. With this information, we have one more biological indicator to take into account when making management and conservation decisions.

Grand Pré, C.A., Thielicke, W., Diaz Jr., R.E., Hedrick, B.A., Elsey, R.M. and Schachner, E.R. (2023). Validating osteological correlates for the hepatic piston in the American alligator (*Alligator mississippiensis*). PeerJ 11: e16542.

Abstract: Unlike the majority of sauropsids, which breathe primarily through costal and abdominal muscle contractions, extant crocodilians have evolved the hepatic piston pump, a unique additional ventilatory mechanism powered by the diaphragmaticus muscle. This muscle originates from the bony pelvis, wrapping around the abdominal viscera, extending cranially to the liver. The liver then attaches to the caudal margin of the lungs, resulting in a sub-fusiform morphology for the entire "pulmo-hepatic-diaphragmatic" structure. When the diaphragmaticus muscle contracts during inspiration, the liver is pulled caudally, lowering pressure in the thoracolumbar cavity, and inflating the lungs. It has been established that the hepatic piston pump requires the liver to be displaced to ventilate the lungs, but it has not been determined if the lungs are freely mobile or if the pleural tissues stretch ventrally. It has been hypothesized that the lungs are able to slide craniocaudally with the liver due to the smooth internal ceiling of the thoracolumbar cavity. We assess this through ultrasound video and demonstrate quantitatively and qualitatively that the pulmonary tissues are sliding craniocaudally across the interior thoracolumbar ceiling in actively ventilating live juvenile, sub-adult, and adult individuals (n= 7) of the American alligator (*Alligator mississippiensis*) during both natural and induced ventilation. The hepatic piston is a novel ventilatory mechanism with a relatively unknown evolutionary history. Questions related to when and under what conditions the hepatic piston first evolved have previously been left unanswered due to a lack fossilized evidence for its presence or absence. By functionally correlating specific characters in the axial skeleton to the hepatic piston, these osteological correlates can be applied

to fossil taxa to reconstruct the evolution of the hepatic piston in extinct crocodylomorph archosaurs.

Poulsen, C.F.B., Munk, K., Wang, T. and Damkkjaer, M. (2023). Transesophageal echocardiography of cardiac function in Nile crocodiles - A novel tool for assessing complex hemodynamic patterns. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 288 (https://doi.org/10.1016/j.cbpa.2023.111564).

Abstract: The crocodilian heart is unique among reptiles with its four-chambered structure and complete intracardiac separation of pulmonary and systemic blood flows and pressures. Crocodiles have retained two aortic arches; one from each ventricle, that communicate via Foramen of Panizza, immediately distally from the aortic valves. Moreover, crocodiles can regulate vascular resistance in the pulmonary portion of the right ventricular outflow tract (RVOT). These unique features allow for a complex regulation of shunting between the pulmonary and systemic circulations. Studies on crocodile shunting have predominantly been based on invasive measurements, but here we report on the use of echocardiography. Experiments were performed on seven pentobarbital anaesthetized juvenile Nile crocodiles (length and mass of 192 ± 13 cm and 26 ± 5 kg, respectively). Echocardiographic imaging was performed using a transesophageal (TEE) approach. All images were EKG-gated. We obtain excellent views of cardiac structures and central vasculature through the esophagus. Standard imaging planes were defined for both long- and short axis views of the left ventricle and truncus arteriosus. For the RV, only a short axis view could be obtained. Color Doppler was used to visualize flow. Pulsed waved Doppler for measuring flow profiles across the atrioventricular valves, in the two RVOTs and the left ventricular outflow tract. Shunting across the Foramen of Panizza could be visualized and gated to the EKG. TEE can be used to image the unique features of the crocodile heart and allow for in-vivo imaging of the complex shunting hemodynamics, including timing of cardiac shunts.

Ortega, S., Hilevski, S. and Hernandez, O. (2023). Captive breeding of *Crocodylus intermedius* (Graves, 1819) under different stocking densities. Herpetology Notes 16: 941-948.

Abstract: *Crocodylus intermedius* is restricted to the Orinoco River basin in Colombia and Venezuela and one of the most endangered New World crocodile species. To determine optimal rearing density and to improve rearing conditions of *C. intermedius*, we worked with 228 captive-reared crocodiles housed in concrete enclosures and distributed into three densities. Crocodiles were fed five days per week and measured at one, six, and 11 months of age. These data were used to calculate a body condition index (BCI) as well as weight and length gain of each individual. Our results indicated that animals reared at a low density (1.82 m^2/individual) were longer and heavier than animals reared at medium density (0.71 m^2/individual) and high density (0.54 m^2/individual). These data confirm that growth of *C. intermedius* is density-dependent, as in other crocodilian species. However, crocodiles reared at lowest density also attained the highest BCI. This confirms that the Orinoco Crocodile exhibits faster development at low densities. BCI estimates indicate that adding a second shelter was only beneficial at low stocking densities, whereas at high densities there were adverse effects on both weight and length gain. Use of a shelter and selecting a density that allowed rearing a maximum number of individuals while promoting a fast growth rate is beneficial for both conservation and commercial perspectives.

Perrichon, G., Pochat-Cottilloux, Y., Conedera, D., Richardin, P., Fernandez, V., Hautier, L. and Martin, J.E. (2023). Neuroanatomy and pneumaticity of the extinct Malagasy "horned" crocodile *Voay robustus* and its implications for crocodylid phylogeny and palaeoecology. Anatomical Record (Hoboken) (doi: 10.1002/ar.25367).

Abstract: *Voay robustus*, the extinct Malagasy "horned" crocodile, was originally considered to be the only crocodylian representative in Madagascar during most part of the Holocene. However, Malagasy crocodylian remains have had confused taxonomic attributions and recent studies have underlined that *Crocodylus* and *Voay* populations coexisted on the island for at least 7500 years. Here, we describe the inner braincase anatomy of *Voay robustus* using x-ray computed tomography on four specimens, to provide new anatomical information that distinguishes *Voay* from *Crocodylus*, especially features of the brain endocast and the paratympanic sinuses. Geometric morphometric analyses are performed on 3D models of the internal organs to compare statistically *Voay* with a subset of extant Crocodylidae. Following these comparisons, we build an endocranial morphological matrix to discuss the proposed phylogenetic affinities of *Voay* with Osteolaeminae from an endocranial point of view. Additionally, we discuss the use of internal characters in systematic studies and find that they can have a major impact on morphological analyses. Finally, new radiocarbon data on Voay and subfossil *Crocodylus* specimens are recovered between 2010 and 2750 cal BP, which confirm the cohabitation of the two species in the same area for a long period of time. We thus assess several extinction scenarios, and propose a slightly different ecology of *Voay* compared to *Crocodylus*, which could have allowed habitat partitioning on the island. Our approach complements information obtained from previous molecular and morphological phylogenies, as well as previous radiocarbon dating, together revealing past diversity and faunal turnovers in Madagascar.

Joanen, T., Mikolajczyk, A.P., Staton, M., Kaplan, J., Holmes, W.E. and Zappi, M.E. (2023). Impacts of diet on reproductive performance of captive American alligators (*Alligator mississippiensis*). Animals (Basel) 13(24) (doi: 10.3390/ani13243797).

Abstract: Historically, there has been little success with the captive breeding of American alligators (*Alligator mississippiensis*) for both commercial and conservative purposes. This study, conducted at Golden Ranch in Gheens, LA, between 2016 and 2022, utilized a newly formulated commercial feed and practical dietary supplementation (crawfish waste products) to enhance egg production, fertility, and hatch rates. The primary focus of this study was to compare the outcome of this captive breeding program at Golden Ranch with a program conducted at Rockefeller Refuge (RR) between 1979 and 1984. Notable success was achieved in terms of reproductive performance in comparison to the captive breeding program conducted at Rockefeller Refuge. In this study, 16.1 hatchlings were produced per nest on Golden Ranch from captive breeders. Additionally, when wild nests from Golden Ranch were incubated in the same controlled environmental chambers, they produced an average of 16.3 hatchlings per nest. This comparison emphasizes the similarity in egg production between captive-bred *A. mississippiensis* and their wild counterparts. The findings of this study suggest that a closed farming system for *A. mississippiensis* can be established by employing captive breeders derived from artificially incubated wild eggs. Furthermore, American alligators raised in controlled environmental chambers during their initial three years of life demonstrated adaptability to captive conditions and tolerated stocking rates associated with farming conditions and served as breeding stock.

Tankrathok, A., Mahong, B., Roytrakul, S., Daduang, S., Temsiripong, Y., Klaynongsruang, S. and Jangpromma, N. (2024). Proteomic analysis of crocodile white blood cells reveals insights into the mechanism of the innate immune system. Heliyon 10: e24583.

Abstract: Crocodiles have a particularly powerful innate immune system because their blood contains high levels of antimicrobial peptides. They can survive injuries that would be fatal to other

animals, and they are rarely afflicted with diseases. To better understand the crocodile's innate immune response, proteomic analysis was performed on the white blood cells (WBC) of an *Aeromonas hydrophila*-infected crocodile. Levels of WBC and red blood cells (RBC) rapidly increased within 1 h. In WBC, there were 109 up-regulated differentially expressed proteins (DEP) that were up-regulated. Fifty-nine DEPs dramatically increased expression from 1 h after inoculation, whereas 50 up-regulated DEPs rose after 24 h. The most abundant DEPs mainly had two biological functions, 1) gene expression regulators, for example, zinc finger proteins and histone H1 family, and 2) cell mechanical forces such as actin cytoskeleton proteins and microtubule-binding proteins. This finding illustrates the characteristic effective innate immune response mechanism of crocodiles that might occur via boosted transcription machinery proteins to accelerate cyto-skeletal protein production for induction of phagocytosis, along with the increment of trafficking proteins to transport essential molecules for combating pathogens. The findings of this study provide new insights into the mechanisms of the crocodile's innate immune system.

Crossley III, D.A., Crossley, J.L., Conner, J.L., Smith, B., Elsey, R., Nelson, D. and Wang, T. (2024). Short communication: Characterizing arterial and venous blood gases over the gas exchange surface, the chorioallantoic membrane, of embryonic American alligators (*Alligator mississippiensis*) at two points of development. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology (https://doi.org/10.1016/j.cbpa.2024.111575).

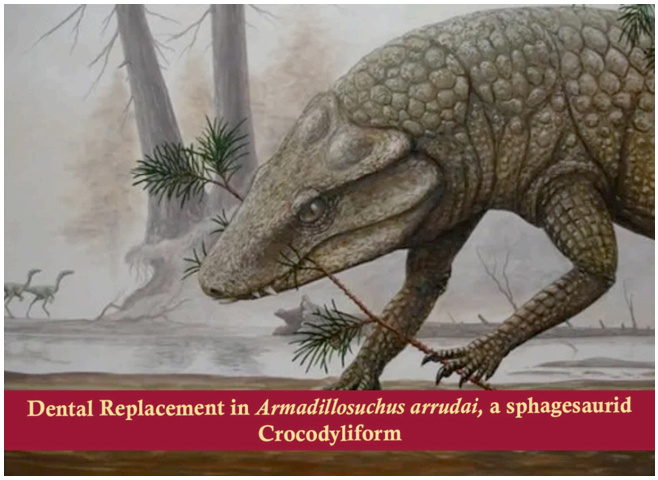
Abstract: Assessments of arterial and venous blood gases are required to understand the function of respiratory organs in animals at different stages of development. We measured blood gases in the arteries entering and veins leaving the chorioallantoic membrane (CAM) in embryonic alligators (*Alligator mississippiensis*). The CAM accounts for virtually all gas exchange in these animals, and we hypothesized that the CAM vasculature would be larger in eggs incubated in hypoxia (10% O_2 for 50% or 70% of incubation), which would be reflected in a lower partial pressure of CO_2 (PCO_2). Contrary to this hypothesis, our measurements revealed no effects of hypoxic incubation on PCO_2, and seemingly no increase in vascularization of the CAM in response to incubation in 10% O_2. PCO_2 was lower on the venous side, but only significantly different from arterial blood at 70% of incubation. The calculated blood flow to the CAM increased with development and was lower in both groups of alligators that had been incubated in hypoxia. Future studies should include measurements of blood parameters taken from embryos held in conditions that mirror incubation O_2 levels, in combination with direct measurements of CAM artery blood flow.

Clarac, F., Campos, Z. and Marquis, O. (2024). The extended osteoderm shield in *Paleosuchus* sp.: A dwarf crocodylian adaptation to the equatorial forest ecosystem? HAL-04382415 (https://hal.science/hal-04382415).

Abstract: The crocodylian dwarf species (ie *Osteolaemus* sp. and *Paleosuchus* sp.) that live in the equatorial forests all share the peculiarity to present an osteoderm shield which extends beyond the dorsal area that lies between the skull and the caudal crest symphysis. Here we study both the morphology and the microanatomy of the osteoderms in *Paleosuchus palpebrosus* in order to both assess the distribution of bone ornamentation over the osteoderm shield and to compare the porosity between the dorsal osteoderms with the non-dorsal osteoderms. Since both the ornamental pit excavation and the bone porosity are relevant proxies to the osteoderm blood vessel content, we thus mapped the repartition of the vascular network within the osteoderm shield in *P. palpebrosus*. Our results show that both the bone ornamentation and the bone porosity are significantly more pronounced within the dorsal shield osteoderms. The interpretation of our results leads to argue that the dorsal osteoderms may be involved in heat transfer via the superficial blood vessels that are located in the ornamental pits if they are artificially exposed to a basking lamp in captive conditions; it is however unlikely to be the case under the canopy of the equatorial forest since the sun exposure is poor. We therefore hypothesize that the dwarf crocodylian extended osteoderm shield should mostly consist of a labile calcium resource that would allow to buffer the diet variations which are related to the various equatorial forest niches (ie streams, excavated pools, jungle floors, caves).

De Tolvo Borsoni, B., De Souza Carvalho, I. and Da Silva Marinho (2024). *Armadillosuchus arrudai* (Sphagesauridae, Crocodyliformes), Adamantina Formation (Turonian - Santonian), Bauru Basin, southeastern Brazil: Dental development aspects. Cretaceous Research (https://doi.org/10.1016/j.cretres.2024.105838).

Abstract: *Armadillosuchus arrudai*, an extinct crocodyliform, has a complex pattern of tooth replacement. Replacement of functional teeth followed an alternating numerical and directional wave from posterior to anterior. Notably, the presence of an initial fossa in some teeth indicated root resorption and facilitated the development of tooth replacement. These aspects suggest a coordinated tooth replacement process, enabling the animal to maintain functional dentition. This study provides insights into the unique dental dynamics of *Armadillosuchus arrudai*, highlighting its lifelong polyphyodonty and the meaning of alternating replacement patterns. Microtomography allowed the comprehension of these intricate tooth replacement processes.



Cashin, K., Martinez, S., Magnin, G. and Nevarez, J.G. (2024). Pharmacokinetics of single intramuscular administration of ceftiofur crystalline free acid in American alligators (*Alligator mississisippiensis*). Journal of Zoo and Wildlife Medicine 54(4): 721-727.

Abstract: A pharmacokinetic study of ceftiofur crystalline free acid sterile oil suspension (CCFA) was performed in six apparently healthy juvenile American alligators (*Alligator mississippiensis*). A single intramuscular dose of 30 mg/kg was administered in the triceps muscle. Blood samples were collected prior to treatment and at 4, 12, 24, 48, 72, 120, 144, 192, 288, and 366 h post administration. Plasma samples were analyzed for ceftiofur equivalent concentrations using liquid chromatography-mass spectrometry. Pharmacokinetic parameters were determined by noncompartmental analysis. Mean peak plasma concentration was 23.2 μg/ml (range, 16.0-27.9), median time to maximum concentration was 72 h (range, 72-120), mean area under the curve from 0 to 366 h postdose was 4.24 h·mg/ml (range, 3.54-4.97), and mean terminal half-life was 143 h (range, 90.8-220). Plasma concentrations were maintained above the minimum inhibitory concentration for this study of 2.0 μg/ml, which was established from similar CCFA pharmacokinetic studies in other

reptilian species, through the end of the data collection of 366 h. Because of prolonged plasma concentrations, a dosing interval could not be established in this study. Future studies should include extended collection time points and multidose studies to determine dosing regimens.

Young, M.T., Wilberg, E.W., Johnson, M.M., Herrera, Y., De Andrade, M.B., Brignon, A., Sachs, S., Abel, P., Foffa, D., Fernandez, M.S., Vignaud, P., Cowgill, T. and brusatte, S.L. (2024). The history, systematics, and nomenclature of Thalattosuchia (Archosauria: Crocodylomorpha). Zoological Journal of the Linnean Society (https://doi.org/10.1093/zoolinnean/zlad165).

Abstract: The use of more than one nomenclatural code is becoming increasingly common in some biological sub-disciplines. To minimize nomenclatural instability, we have decided to establish a higher level systematization for Thalattosuchia under both the International Code of Phylogenetic Nomenclature ('PhyloCode') and the International Code of Zoological Nomenclature ('Zoological Code'). We undertook a series of phylogenetic analyses with an expanded dataset to examine the origins of Thalattosuchia within Crocodylomorpha, and determined the clade's diagnostic characters. Based on these analyses, we provide updated diagnoses for Thalattosuchia and its subclades under both the PhyloCode and Zoological Code. We also introduce two new nomina that are regulated under the PhyloCode (Neothalattosuchia and Euthalattosuchia), and the nomen Dakosaurina, which is registered under both nomenclatural codes. Moreover, we introduce PhyloCode-compliant phylogenetic definitions for Thalattosuchia and its subclades. As we cannot reliably discriminate between the positional hypotheses for Thalattosuchia within Crocodylomorpha, the clades' origins are as much of a mystery today as they were over a century ago. However, we hope that using the same diagnostic characters to define the same clades, with the same nomina, under both nomenclatural codes will be an example to others to follow.

Navarro, T.G., Cerda, I.A., Fernández Dumont, M.L., Apesteguía, S. and Pol, D. (2024). New data on the bone histology of *Araripesuchus buitreraensis* (Crocodylomorpha: Notosuchia) from the Late Cretaceous of Argentinean Patagonia. Historical Biology (https://doi.org/10.1080/08912963.2023.2301140).

Abstract: *Araripesuchus* is a genus of Notosuchia from the Upper Cretaceous of southern continents. A previous paleohistological study performed in individuals assigned to one of the South American the species (*Araripesuchus buitreraensis*) has revealed, among other palaeobiological inferences, cyclical and slow growth dynamics. To increase the knowledge about the growth dynamics and intraskeletal and interspecific histological variation, here we analyse the microstructure of femur, tibia, fibula, metatarsal (II, III and IV) and two osteoderms of an individual referred to *Araripesuchus* cf. *buitreraensis* (MPCA-Pv 263) from the Late Cretaceous of Argentina. All elements present a cortex formed by both parallel fibred and lamellar bone tissues interrupted by lines of arrested growth (LAGs), revealing a general slow growth rate annually interrupted. A similar growth strategy has been inferred for other notosuchians, as *Iberosuchus macrodon*, but an important variation regarding this parameter is evident in the clade. Although the bone tissue suggests that the individual reached the sexual maturity (ie increasing in the intrinsic fibre arrangement in the outer cortex), the absence of an external fundamental system indicates that somatic maturation has not been attained. MPCA-Pv 263 exhibit discrete layer of WFB in the cortical bone whose origin is still unambiguous.

So, W.L., Chong, T.K., Lee, I.H.T., So, M.T.W., Liu, A.M.Y., Leung, S.T.C., Ching, W., Yip, H.Y., Shaw, P.C. and Hui, J.H.L. (2024). Cytochrome oxidase I DNA barcodes of crocodilians meat selling in Hong Kong. Scientific Data 11: 46.

Abstract: The crocodilians include true crocodiles, alligators, caimans, and gharial, and the trade of crocodilian products is regulated in accordance with the Convention of Wild Fauna and Flora (CITES). Hong Kong does not have her own wild crocodilians; thus, all crocodilians meat available is presumably imported with proper license. Here, we obtained a dataset of cytochrome oxidase I (COI) gene markers of 114 crocodilian meat samples (including frozen and dried crocodilian meat products) available in the contemporary market. We have also validated these barcodes in a phylogenetic approach with other data deposited on the GenBank, and detected 112 samples belonging to four crocodile species *Crocodylus siamensis*, *C. porosus*, *C. niloticus* and *Alligator mississippiensis*, and 2 samples belonging to snake *Malayopython reticulatus*. The dataset generated in this study will be useful for further studies including meat inspection, illegal trading, and enhancement of international and local legislations on illegal reptile importation.

Cox, T. (2023). Can Illicit Drugs be Detected in Predators? A Case Study for *Alligator mississippiensis* as Sentinels for Methamphetamine and Related Analyte Contamination. MSc thesis, Texas Tech University, Texas, USA.

Abstract: The Gulf of Mexico is a vast area that includes many different habitats such as mangroves, estuaries, and swamp lands. This area includes both highly urbanized areas and more remote areas. Many studies of environmental contaminants cover substances such as pesticides, pharmaceuticals, and personal care products. However, in more recent years a new class of contaminant is starting to surface: illicit drugs. This study focuses on the detection of such contaminants, specifically amphetamine, MDA, MDEA, MDMA, and methamphetamine, in the predator species the American *Alligator mississippiensis* collected from a hide check station representing a highly urbanized area, Houston, TX, and a protected wildlife area, the Rockefeller Wildlife Refuge in Grand Chenier, LA. *A. mississippiensis* are of particular interest as they are not only apex predators, but they are considered environmental indicators as well as trophic regulators. Given that this species is a highly opportunistic predator, it is suggested that there may be a potential for this novel set of contaminants to be transferred an apex predator through environmental exposure and/or trophic transfer through contaminated prey items. This study utilizes tissues adipose, liver, and scutes collected from alligators in the Houston, TX area and the Rockefeller Wildlife Refuge in Grand Chenier, LA. Tissues were homogenized and processed using QuECHERS salt extraction methods. Chemical analysis using liquid chromatography-mass spectrometry (LC-MS) indicates that amphetamine was found in alligator adipose, liver and scute tissue at both locations in the range of none found up to 33.650 ppb. This study will highlight the use of various tissue samples to determine the narcotic concentrations in an apex species along with. Statistical analysis for differences between sites (urbanized vs protected), age class, and sex of the individuals revealed consistent significances between contaminant concentrations and location of samples ($p = 0.002$ for methamphetamine and $p = <0.001$ for amphetamine) along with significant differences in contaminant concentrations found across age class ($p = 0.030$, <0.001, and 0.022) for methamphetamine, amphetamine, and MDEA respectively.

Stalter, L., Terry, M., Riley, A. and Leeds, A. (2024). Home is where the home range is: Identifying territoriality and exhibit preferences in an *exsitu* group of all-male Nile crocodiles (*Crocodylus niloticus*). PLoS ONE 19(1): e0297687.

Abstract: Here, the presence or absence of territoriality was evaluated in an all-male Nile crocodile (*Crocodylus niloticus*) group living in an ex-situ environment. Location data for each crocodile within the exhibit were collected three times per day over a two-year period, including two warm seasons and two cold seasons. A geographic information system (GIS) was used to create seasonal home ranges and core areas for each crocodile, to quantify the overlap of these

home ranges and core areas to assess potential territoriality, and to calculate exhibit preferences of the group. Core area overlap was significantly lower than home range overlap, suggesting the crocodiles established territories within their exhibit. This pattern of behavior was similar across seasons, though it moderately intensified during the cold season. The crocodiles appeared to be more territorial in water, as overlap was most concentrated on the central beach, the only feature utilized more than expected based in its availability in the exhibit. These findings highlight the behavioral complexity of Nile crocodiles in human care, specifically the ability of Nile crocodiles to adapt to *ex-situ* environments similar to their wild counterparts by forming territories despite spatial constraints. Identifying the presence of territorial behavior is important for the care and welfare of *ex-situ* animals, as territorial animals have specific requirements that may result in increased agonism when unmet. It can also provide valuable context to aid in mitigation strategies, for example, when undesirable levels of agonism do occur. The findings here provide an example of how methodology from the wildlife ecology field can be adapted to *ex-situ* settings using a GIS and contributes to the current understanding of crocodilian behavior in human care.

Coleman, T.S., Gabel, W., Easter, M., McGreal, M., Marin, M.S., Garrigos, D.B. and Murray, C.M. (2024). The spatial ecology of nuisance crocodiles: Movement patterns of relocated American crocodiles (*Crocodylus acutus*) in Guanacaste, Costa Rica. Animals 14: 339.

Abstract: Anthropogenic alterations of the environment have increased, highlighting the need for human-wildlife coexistence and conflict mitigation. Spatial ecology, and the use of passive satellite movement technology in particular, has been used to identify patterns in human-wildlife conflict as a function of shared resources that present potential for dangerous situations. Here, we aim to remotely identify patterns indicative of human-crocodile conflict in Guanacaste, Costa Rica by exploring site fidelity and diverse modes of movement (ie land and water) across space between nuisance (relocated) and non-nuisance (wild) crocodiles. Advanced satellite remote sensing technology provided near-constant movement data on individuals at the regional scale. Telonics Iridium SeaTrkr-4370-4 transmitters were used with modified crocodilian fitting. Results indicate that relocated crocodiles exhibited large-scale movements relative to wild crocodiles. Nuisance relocated crocodiles either returned to the area of nuisance or potentially attempted to in short time frames. The results presented here highlight the need for alternative management strategies that facilitate relocation efficacy.

Aswani, S. and Matanzima, J. (2024). Human-crocodile interactions in the western Solomon Islands: the importance of local data for reducing attacks on people. Oryx (doi:10.1017/S003060532300176X).

Abstract: Interactions between people and the saltwater crocodile *Crocodylus porosus* frequently occur on islands and in coastal regions. Saltwater crocodiles impact people's lives and livelihoods by attacking them, resulting in minor or serious injuries, and by interfering in people's foraging activities. Retaliation may include killing the crocodiles involved. To reduce such human-crocodile interactions, data about the occurrence of incidents are required. We present data on encounters with crocodiles and attacks on people in the Roviana Lagoon, Solomon Islands. Data includes time of incident, gender, age and activity of the victim, water conditions and what happened to the crocodile after the incident. We used a questionnaire to capture the details of incidents that occurred during 2000-2020 in the villages of Dunde, Baraulu, Nusa Hope and Kozou. Most incidents were in the evening, mostly involving women, and most victims were aged 20-39 years or ≥60 years. In all cases people were attacked while gleaning for shellfish in the mangroves. Attacks occurred irrespective of whether the water was clear or murky, and in all cases the crocodiles were not killed. Such site-specific data will facilitate the formulation of strategies for reducing negative interactions between people and crocodiles in this particular location. Although the saltwater crocodile is categorized as Least Concern on the IUCN Red List, research such as this provides data that can be used for promoting coexistence with and conservation of this species used for promoting coexistence with and conservation of this species.

Vashistha, G., Ranjan, V., Singh, D., Ugemuge, S.S., Badhawan, A.D. and Gupta, P. (2024). Status of the Critically Endangered gharial *Gavialis gangeticus* in the upper Ghaghara River, India, and its conservation in the Girwa-Ghaghara Rivers. Oryx (doi:10.1017/S0030605323001485).

Abstract: The gharial *Gavialis gangeticus* is a Critically Endangered crocodilian endemic to the Indian subcontinent. Habitat modification by river damming and water extraction has caused a severe decline in its population. The status of the gharial is known within protected areas, but there have been few surveys for this species in unprotected areas. In Katerniaghat Wildlife Sanctuary, a breeding gharial population in Girijapuri Barrage Reservoir has low recruitment, and it has been hypothesized that yearlings disperse downstream into the unprotected Ghaghara River when the barrage gates are opened. We surveyed a 100-km stretch of the Ghaghara River from the Girijapuri Barrage to Chahlari Ghat, observing a total of 84 gharials, including a high proportion of juveniles. A survey in 2021 from Chahlari Ghat to Ayodhya observed 174 gharials, giving a combined total of 258 gharials in a 219-km stretch of the Ghaghara River for the two surveys. Together, these findings confirm the presence of a significant population of gharials in the Ghaghara River. We recommend the adoption of an integrated approach, involving government agencies and local communities along the river, to conserve the protected Girwa-Kaudiyala Rivers and the unprotected Ghaghara River for gharial conservation and recovery. Such a programme will need to tackle the threats facing the gharial and establish baseline data and long-term monitoring protocols for freshwater species conservation in this river system.

Meeks, D., Morton, O. and Edwards, D.P. (2023). Wildlife farming: Balancing economic and conservation interests in the face of illegal wildlife trade. Paople and Nature (doi: 10.1002/pan3.10588).

Abstract: Demand for wildlife and their products continues to grow, often despite increasingly militarised regulation and consumer awareness campaigns. We review the sustainability, legality and feasibility of wildlife farming of animals, as a potential conservation tool to ensure the development of an equitable and sustainable trade model. While there are some positive examples of well-managed wildlife farming in trade, we identify common themes of misuse including the intentional mislabelling of wild-caught specimens in global trade and the use of wild-caught individuals to supplement captive stocks. We also highlight the frequent failure to incorporate biological data into management strategies, resulting in the widespread use of species with potentially unfavourable life history traits, which constrain the economic and biological sustainability of wildlife farming programmes. We develop a structured decision framework to aid the examination of when wildlife farming may most benefit or hinder species conservation. Synthesis and applications. Key opportunities include developing species suitability assessments and removing barriers to legitimate participation with wildlife farming among poor, rural communities. In the absence of management strategies that address the issues of species suitability and accessibility, wildlife farming will continue to place significant strain on wild populations while failing to provide conservation value and sustainable economic returns.

Tanna, P., Vyas, R. and Mori, D. (2024). A Grey Heron *Ardea cinerea* preying on a mugger *Crocodylus palustris* hatchling. Indian Birds 19(5): 162.

Székely, D., Stănescu, F., Székely, P., Telea, A.E. and Cogălniceanu, D. (2024). A review of age estimation methods in non-avian reptiles by growth marks in hard tissues. Integrative Zoology (doi: 10.1111/1749-4877.12808).

Abstract: Age and growth-related data are basic biological parameters, essential in population ecology, evolution, and conservation biology. There is a growing body of published information on reptile demography derived from sclerochronology, a technique based on counting the growth layers deposited in bones (skeletochronology) and other hard body structures. Since the data are not always easily available, we compiled the existing published data, described the current status of knowledge, synthetized the conclusions of disparate studies, and identified patterns of research and information gaps, prioritizing the needs for future research. Our database includes the results of 468 published studies covering 236 reptile species from 41 families. These represent less than 2% of the total number of known extant species. Turtles and crocodiles are proportionally better studied, while snakes are the least examined group. The distribution of the research does not reflect conservation needs; we found an important geographic bias, with an overrepresentation of Northern temperate species. Only 23% of the studies checked the assumption of periodicity of growth marks deposition, and the method was found to be reliable or adequate in 79% of the cases. Overall, the data obtained through sclerochronology can be considered robust, especially if validation methods are employed, since the general goal is to characterize population parameters, trends, and dynamics, rather than determining the exact age of any specimen in particular.

Iijima, M., Mayerl, C.J., Munteanu, V.D. and Blob, R.W. (2024). Forelimb muscle activation patterns in American alligators: Insights into the evolution of limb posture and powered flight in archosaurs. Journal of Anatomy (doi: 10.1111/joa.14011).

Abstract: The evolution of archosaurs provides an important context for understanding the mechanisms behind major functional transformations in vertebrates, such as shifts from sprawling to erect limb posture and the acquisition of powered flight. While comparative anatomy and ichnology of extinct archosaurs have offered insights into musculoskeletal and gait changes associated with locomotor transitions, reconstructing the evolution of motor control requires data from extant species. However, the scarcity of electromyography (EMG) data from the forelimb, especially of crocodylians, has hindered understanding of neuromuscular evolution in archosaurs. Here, we present EMG data for nine forelimb muscles from American alligators during terrestrial locomotion. Our aim was to investigate the modulation of motor control across different limb postures and examine variations in motor control across phylogeny and locomotor modes. Among the nine muscles examined, m. pectoralis, the largest forelimb muscle and primary shoulder adductor, exhibited significantly smaller mean EMG amplitudes for steps in which the shoulder was more adducted (i.e., upright). This suggests that using a more adducted limb posture helps to reduce forelimb muscle force and work during stance. As larger alligators use a more adducted shoulder and hip posture, the sprawling to erect postural transition that occurred in the Triassic could be either the cause or consequence of the evolution of larger body size in archosaurs. Comparisons of EMG burst phases among tetrapods revealed that a bird and turtle, which have experienced major musculoskeletal transformations, displayed distinctive burst phases in comparison to those from an alligator and lizard. These results support the notion that major shifts in body plan and locomotor modes among sauropsid lineages were associated with significant changes in muscle activation patterns.

Wilkie, C., Tellez, M., Jones, G. and Genner, M.J. (2024). Population genetic structure of Morelet's and American crocodiles in Belize: hybridization, connectivity and conservation. Conservation Genetics (https://doi.org/10.1007/s10592-023-01590-7).

Abstract: Hybridization can influence the evolutionary potential of wild species and can be especially detrimental where one species is abundant, and the other much rarer. In Belize, the Morelet's crocodile (*Crocodylus moreletii*) primarily inhabits inland freshwater lagoons, lakes and rivers, whereas the less abundant American crocodile (*Crocodylus acutus*) is more prevalent among the offshore cayes and atolls. Both species are historically sympatric along the brackish coastline, but it is unclear if admixture between the two is affecting genetic integrity of the species. We investigated the extent of interspecific hybridization across Belize using genomic variants identified using double digest restriction-site associated DNA sequencing (ddRADseq). Five groups of genetically pure *C. moreletii* were identified, two of which were inland, including the protected Chiquibul National Park. Two groups of genetically pure *C. acutus* were identified, one on northern offshore islands, and a second along the southern coastline. Hybrids were only identified along the central-southern coastline and were in close geographic proximity to coastal purebreds. Based on these results, we suggest that the central-southern coastline represents a hybrid zone, while the inland areas and offshore islands that harbour only genetically pure populations may benefit from conservation prioritisation.

Jia, C. (2024). Caiman tales: new enlightenments about species conservation risks. Proceedings Volume 12924, Third International Conference on Biological Engineering and Medical Science (ICBioMed2023); 129242R (2024) https://doi.org/10.1117/12.3012910).

Abstract: *Caiman* is a genus of medium-sized crocodilians, which comprises three officially acknowledged species, native to South and Central America with a wide range of geographical distribution. They have been served for skin demand, meat supply, pet breeding and many other purposes since the 20th century. Thanks to high populations and the wide distribution, the genetic diversity of caimans reveals to be high and the existence of cryptic species in *Caiman* is questioned due to the lack of data from molecular analysis. All three members within *Caiman* are not considered to be threatened at the protection level. However, the lack of genetic analysis might challenge this harmony since some species may be divided into multiple new ones due to cryptic species concerns. Hence the old evaluation of populations and protection levels may not be applied to those new ones. Many recent works focusing on genetic diversity and phylogeny analysis in *Caiman* have demonstrated problems of the underestimated genetic complexity of lineages. This review evaluates publications of the *Caiman* genus with phylogenetic concerns and compares them to examples of separation of other crocodilian species from last decades to discuss the cryptic species in *Caiman* and provide outlines for future protective operations.

Khadka, B.B., Bashyal, A. and Griffith, P. (2024). Population changes in Gharials (*Gavialis gangeticus*) vary spatially in Chitwan National Park, Nepal. Reptiles & Amphibians 31: e21018

Abstract: Gharials, large crocodilians found only in South Asia, are widely seen as a flagship species for river conservation in Nepal, especially in Chitwan National Park, where a headstart program has supplemented the population since 1981. The population has shown signs of recovery only in the last decade, so continued monitoring of population trends is vital for conservation. We conducted annual winter population surveys for gharial in Chitwan between 2017 and 2022, during which we also characterized riverbank substrate availability and basking preferences. We documented potential threats to the species in Chitwan throughout the year. Overall, we counted an increasing number of Gharials in Chitwan; however mixed-effects modelling of Gharial encounter rate showed that increasing encounters rates are not evenly distributed throughout available habitat, with some river stretches having stable or decreasing trends. Encounter rates on the Rapti River increased in all transects, compared to more variable results on the Narayani River, likely attributable to higher levels of human disturbance and

the impact of captivity on habitat selection. Fewer Gharials were seen in transects with high levels of disturbance due to sand mining and the extraction of river substrates, highlighting this threat as a major concern. Regular reports of bycatch in illegal gillnets was the major observed source of mortality. A lack of an increasing population trend in the stretch above a large barrage suggests that recruitment is minimal in this area, and the dam likely has a negative impact on upstream Gharial recruitment. We cautiously suggest that the Chitwan population is recovering, but that recovery is hampered by threats, especially substrate extraction, illegal gillnet fishing, and river fragmentation by a dam.

Stannard, C.R., Lansdell, L.E. and Lindrew, S. (2024). Application of experimental patternmaking techniques to increase utilization and creative potential of American alligator leather. International Textile and Apparel Association Annual Conference Proceedings 80(1) (doi: https://doi.org/10.31274/itaa.17391).

Abstract: Today, a major issue facing the American alligator leather industry is a surplus of hides in the market which is causing a significant price slump. Finding new uses for alligator leather is of critical importance to regions where alligator is a major agricultural product.Thus, the purpose of the present research was to apply experimental patternmaking techniques (EPT) to determine the best approach for utilizing more of each alligator hide and maximizing the creative potential of alligator leather for fashion. EPT includes subtraction cutting (SC), transformational reconstruction(TR), zero waste (ZW), planar flux (PF), and pattern magic (PM). The design team created five garments using different EPT and alligator leather. The team identified new considerations and provided sustainable design suggestions for using alligator and EPT.

Stannard, C.R. and Lansdell, L.E. (2024). Leveraging technology to maximize cutting yield from wild alligator hides for crafters or small business owners. International Textile and Apparel Association Annual Conference Proceedings 80(1) (doi: https://doi.org/10.31274/itaa.17398).

Abstract: In the Southern US, there are numerous industries devoted to maintaining the American alligator as an agricultural product. However, a severe price slump has occurred in the marketplace for wild alligator hides, which could threaten the entire alligator industry. One solution is to encourage more small craft business owners and hobby leathercrafters to utilize alligator leather. Therefore, the purpose of this research was to determine how to leverage technology to maximize cutting yield from alligator hides. A secondary goal was to find free technology that could easily accomplish this method. To begin, the researchers developed a digitization process for alligator hides that employed Adobe Illustrator and a cell phone camera. Four free programs (Draw Pad Graphic Designer, Inkscape,Vectr, and Vector Q) were then tested. This work has positive implications by creating an easy, free method for crafters and small craft business owners to test their cutting yields for alligator.

Lindrew, S. and Stannard, C.R. (2024). Waste not: Zero waste coat with alligator collar. International Textile and Apparel Association Annual Conference Proceedings 80(1) (doi: https://doi.org/10.31274/itaa.17404).

Abstract: The goal of this project was to apply the zero waste (ZW) experimental patternmaking technique to utilize dimensional parts of the alligator hide and create a visually pleasing design. Traditional patternmaking techniques typically involve flat patterns and flat fabric.Because the legs of the alligator are three-dimensional, they do not lie flat,so they are not easily utilized with traditional patternmaking techniques. The result is that the legs, a large percentage of the alligator hide, are often discarded. This design is an oversized cardigan-style camel-colored 100% wool Melton coat with a wide dark brown alligator collar and vertical alligator gusset at the center back. Smaller pieces of the hide were used to make a knot button and a patchwork belt. The leg sections of the hide were used to create a ruffle effect that makes the collar a focal point of the garment.

Lansdell, L.E. (2024). Cocodrie with pleated illusions. International Textile and Apparel Association Annual Conference Proceedings 80(1) (doi: https://doi.org/10.31274/itaa.17287).

Abstract: The purpose of this design was to create a garment using a wild-caught low-grade alligator skin and an experimental patternmaking technique. A lower-quality alligator skin was chosen due to the number of imperfections found on its surface. The natural holes and scars were incorporated into the yoke creating a unique design and taking into consideration the size and shape limitations of designing with alligator skins. The “parring down and opening out” technique from Nakamichi’s Pattern Magic 3 had not been explored further and expands on McKinney *et al*.’s (2016) research by repeating the principle of the technique around the body on the bodice and skirt. The color contrast between the navy main body fabric and curved vertical pleats in the rust fabric creates an illusion depending on the direction of the viewer.

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