

CROCODILE SPECIALIST GROUP NEWSLETTER

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COVER PHOTOGRAPH: Female American alligator
(*Alligator mississippiensis*) at nest, Louisiana, USA.
Photograph: Ruth Elsey.

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Matthew Shirley, Florida, USA.

Editorial

It is with great sadness that I share the news that George Rabb, SSC Chair from 1989 to 1996, passed away. George was a giant in the conservation world, well-beyond the normal reaches of SSC, IUCN or any of the organizations with which he was engaged. My first dealings with George were in the 1960s, when he was the herpetological editor of *Copeia*, and he went to great lengths to help me with my first real paper. Specialist groups had different classes of members when George took over the SSC, some who could vote and others not. George exercised real foresight in making all SG members equivalent SSC members, putting this problem to bed.

In August 2017 Dr. Angel Alcala was awarded the ASEAN Biodiversity Hero Award. The Government of the Philippines hosted the award ceremony of the inaugural ASEAN Biodiversity Heroes, a program designed to recognize outstanding individuals from the ASEAN region who have contributed significantly to biodiversity conservation and advocacy efforts in their respective countries. Dr. Alcala has been involved in varying capacities with the conservation of the Philippine crocodile (*Crocodylus mindorensis*) for over 60 years. On behalf of the CSG we pass on our congratulations to him on receiving this award.

Dr. Matt Shirley, CSG Regional Chair for West & Central Africa and Chair of the CSG Future Leaders Working Group, attended the 29th CITES Animals Committee meeting held in Geneva, Switzerland, 18-22 July 2017. He also attended the "National Workshop on Status of Crocodile Conservation in Cuba", held at Playa Giron, Cuba, on 5-9 June 2017. We hope to report on this meeting in the next Newsletter.

The "11th Latin American Congress of Herpetology" was held in Quito, Ecuador, on 24-28 July 2017, with some 450 participants taking part. A crocodile symposium was organized by Dr. Pablo Siroski, Alvaro Velasco and Sergio Balaguera-Reina within the Congress (see summary on pages 7-8).

The Wildlife Conservation Society (WCS) carried out a drone survey in parts of Lake Mesangat, East Kalimantan, Indonesia, in August 2017. Photographs are still being assessed and a report compiled, and a follow-up survey (by drone and boat) is planned for October 2017, with the participation of Dr. Steve Platt and Lonnie McCaskill (CSG Regional Chair for East and Southeast Asia). For the CSG, the active involvement of WCS in the Mesangat issue is warmly welcomed.

I visited Colombia recently and was able to get an update from Giovanni Ulloa and Clara Sierra Diaz on progress being made with the Cispatá Bay Project. At CITES CoP17 Colombia was granted a split-listing for American crocodiles (*Crocodylus acutus*) so that the program at Cispatá, linked directly to livelihoods, could engage in ranching. To implement the program a number of laws need to be changed, and the Ministry of Environment, with which I met during my visit, are in the process of doing this.

The 26th CSG Working Meeting (Santa Fe, Argentina; 7-10 May 2017) is now only some 7 months away. I urge everyone interested in crocodilian management, conservation, management and research to consider attending this important meeting. Details on registration, accommodation, etc. are available on the meeting website (<https://www.25wmcsgsantafe.com>)

Donations have begun to arrive in response to the annual letters of request sent out in July 2017, and I am personally very grateful to all who have made a contribution, past and present. The support of CSG donors, big and small, is critical to the CSG's ability to operate effectively and sustain itself.

Professor Grahame Webb, *CSG Chair*.



Female American alligator (*Alligator mississippiensis*).
Photograph: Ruth Elsey.

CSG Student Research Assistance Scheme

The Student Research Assistance Scheme (SRAS) provided funding to 6 students in the July-September 2017 quarter, and 2 further applications are currently under review. Since 2009, the SRAS program has funded 119 students from 33 countries, undertaking crocodilian research in 39 countries.

1. Clement Aubert (France): Evaluation of the use of drones as a method of surveying crocodiles in West Africa.
2. Winkom Kpoda (Burkina Faso): Impact of conservation measures on the diversity of enteric parasites of crocodiles in Burkina Faso.
3. Joe Partyka (Norway): Anthropogenic impact on the immune function and host-parasite relationship of the American crocodile (*Crocodylus acutus*) in Belize.
4. Meghan Kelley (USA): Examination of how stressors affect the cellular stress response and pheromone production in American alligators.
5. Ethan Woodyard (USA): Molecular characterization of parasites infecting *Alligator mississippiensis*.
6. Jailabdeen A. (India): Acoustic communication in Gharial *Gavialis gangeticus*.

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

Zoos

WORLD TOMISTOMA DAY. The 5th of August came around quickly this year, but World Tomistoma Day (WTD) was celebrated around the planet for the second time - again, recognising the contribution made to the species by the late Ralf Sommerlad. The whole point of having a WTD is to make the public more aware of the species. Such a large, enigmatic crocodilian remains largely unknown outside of those who know crocodilians. This awareness is being achieved through WTD. The main target thus far has been the world's zoos - particularly those that display Tomistoma.

We wish to thank the zoos that took part in celebrating *Tomistoma schlegelii* this year, and direct you to the website (www.crocdays.org) for further information on the institutions participating. Many of the zoos featured special talks by guest CSG-Tomistoma Task Force members, presentations and activities (word searches, cross word puzzles, colouring games) for visitors, especially children.

Although the main aim is currently to raise awareness, for the second year running, Croc Encounters in Tampa (Florida, USA) used WTD to raise funds for CSG-TTF, themselves matching the donations from visitors. We are grateful to them for the continued support. Other zoos have donation stations situated near their Tomistoma display for visitors to contribute.

In developing WTD, the idea was to build it gradually from lessons learned each year. This year, the organising team have a better understanding of what needs to be done to improve marketing, developing materials (and what materials need to be prepared well in advance), and broadening the network of institutions involved.

Although we have direct feedback from zoo visitors on the impact of WTD, we have no real measure of this. Developing materials for next year's event will increase our ability to assess the practical impact of WTD and increase our reach via printed materials and online marketing. Once again, the team this year was Bekky Muscher-Hodges, Lauren Augustine, Aubrey Shwedick and myself, with much input from CSG-TTF Chair Bruce Shwedick.

Colin Stevenson, Vice Chair, CSG-Tomistoma Task Force (coleosuchus@hotmail.com).

USA

FIRST RECORD OF DOUBLE CLUTCHING IN THE CUBAN CROCODILE (*CROCODYLUS RHOMBIFER*). The captive propagation of crocodilians is an important conservation measure for many species. In addition to breeding and maintaining genetically viable populations at zoological institutions, many species are bred *in-situ* for sustainable use and reintroduction. The Cuban crocodile (*Crocodylus rhombifer* Cuvier, 1832), is listed as Critically Endangered on the IUCN Red List, and is one such species that is propagated in captivity, both *in situ* and *ex situ*. In captivity, *C. rhombifer* reproductive cycles are consistent with those documented in wild populations. Mating occurs from November through May and oviposition takes place mid-April through August (Targarona 2000).

At the Smithsonian's National Zoological Park (NZP), three female *C. rhombifer* breed and lay eggs annually. In June 2016, due to an aggressive interaction, an older female was removed from a breeding group, leaving only a pair, consisting of a 37-year-old female (identified as F2; Augustine *et al.* 2017) and a 47-year-old male (M2). This remaining pair bred and the female produced 35 eggs on 28 April 2017 (Fig. 1). Relative to her average clutch size of 28.8 eggs for 2012-2016 (Table 1), this clutch was above average in size.



Figure 1. Female *C. rhombifer* (F1) sitting on nest in which the first clutch of eggs was laid.

As per standard procedure, the eggs were removed from the enclosure. Of the 35 eggs, 34 banded and one never developed. Because the placement of the nest within the enclosure was a safety concern, the mound was moved approximately 4 m from its original location within the enclosure. The female spent a few weeks moving between the new nest site and the old, but eventually kicked up a small mound and only guarded the original nest site. On 11 June 2017, the enclosure was accidentally flooded, washing away any remnants of either nest. On 20 June 2017, at around 1800 h, the female began to hastily build a new mound nest on the original site, and on 22 June 2017 she began to lay eggs in and around the enclosure pool. She laid a total of 13 eggs, 6 on land that were recovered by staff and 7 in the pool, which she ate just hours after laying. Of the 6 eggs recovered, 5 were translucent, but banded soon after. Staff suspect the second clutch was not laid in the nest due the unfavourable flooding conditions that occurred.

Double-clutching is poorly understood in crocodilians although it has been observed in several captive specimens including *C. palustris* (Andrews 1986; Lang *et al.* 1989; Whitaker and Whitaker 1984), *C. siamensis* (Platt *et al.* 2012; Thuok 1995; Whitaker 2008), *C. intermedius* (Sigler 2008) and *C. mindorensis* (van Weerd 2010). Length of time between clutches has varied from 4-6 weeks in *C. palustris* (Lang *et al.* 1989; Whitaker and Whitaker 1984) to 4-6 months in *C. mindorensis* (van Weerd 2010). In this instance, there were 55 days between the two *C. rhombifer* clutches (Table 1). Additionally, much like 80% of clutches produced by *C. palustris* at the Madras Crocodile Bank Trust and *C. siamensis* in Cambodia, the second clutch for *C. rhombifer* was much smaller than the first clutch. Although not all of the eggs were recovered, those that were developed an opaque band soon after collection. Unfortunately these eggs were not incubated to term, therefore hatching success is unknown.

The rebuilding of a nest after egg collection has been documented in wild populations (Howard and Odgen 1991; Larriera and Piña 2000). This is the first record of

the production of a second clutch within a second nest. In captive populations, double-clutching, once thought to be a unique phenomenon, is being documented in an increasing number of species. *Alligator mississippiensis* have been documented storing sperm; therefore it is conceivable that all crocodilians can store sperm for future fertilization (Gist 2008). Conclusive data on double-clutching in wild populations do not exist, although it has been suggested in *Crocodylus niloticus* (Cott 1961; Graham 1968) and is likely in favourable conditions. There are several potential explanations for the double-clutching seen at NZP. In restricted areas, such as zoo exhibits, resource competition may be exacerbated (Seebacher and Grigg 1997). In this instance competition for mates, nesting sites and basking areas have been documented (Augustine *et al.* 2015, 2017). The removal of the older female from this breeding group reduced the competition within enclosure (Augustine *et al.* 2017), potentially enhancing the reproductive output of the younger animal. Social grouping is an important factor in the captive propagation of crocodilians and competition has been negatively correlated with clutch production in female *C. porosus* (Webb and Messel 1978).

Environmental cues may have instigated the production of the second clutch. Two events may have simulated the loss of the nest: moving the nest and the flooding of the enclosure. Eggs are often lost due to flooding and predation (Dietz and Hines 1980; Fleming *et al.* 1976; Joanen 1969; Joanen and McNeese 1981; Larriera 1994) and these events could have been the catalyst for the production of a second clutch.

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Table 1. Clutch data for F1, a captive female *C. rhombifer*, 2012-2017. *= mean clutch size (CS) of wild and captive *C. rhombifer* reported by Targarona (2000).

Year	Date of Oviposition	Nest Type	Nest Size (m)	Surface Temp. (°C)	Nest Cavity Temp. (°C)	No. of Eggs	Mean Egg Weight (g)
2012	18 Apr 2012	Mound	-	-	-	31	120.8
2013	19 Apr 2013	Mound	1.8 x 1.8 x 0.3	32.4	33.5	30	125.8
2014	25 Apr 2014	Mound	3.0 x 1.0 x 0.5	26.7-38.9	31.3	27	125.0
2015	20 Apr 2015	Mound	1.0 x 0.3 x 0.5	27.8-40	35.6	32	120.2
2016	6 May 2016	Mound	2.9 x 2.1 x 0.6	28.9-30	30	24	120.1
2017	28 Apr 2017	Mound	3.5 x 1.4 x 0.5	37.8-50.6	29.4	35	112.8
2017	22 Jun 2017	Mound	2.8 x 0.8 x 0.2	31.1	N/A	13	117.4
Mean CS (2012-2016)		-	-	-	-	28.8	-
Mean CS - captive *		Mound	2.7 x 2.7 x 1	-	-	25.4	-
Mean CS - wild *		Mound/hole	-	-	-	14.5	-

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United Kingdom

TOMISTOMA BREEDING IN UK. A pair of Tomistoma (*Tomistoma schlegelii*) were acquired in 2015 by Crocodiles of the World, in Oxford, UK. These animals were initially imported from Jong's Crocodile Farm and Zoo (Sarawak, Malaysia) for another UK zoo, but it was unable to house the pair.

The animals were 2.3 m TL (female) and 3.6 m TL (male) when they arrived at Crocodiles of the World. In July 2016 they were placed on display in the large Croc House. Their enclosure measures 15 m x 12 m, with a large pool featuring multiple depths up to 2 m deep. The water is maintained at 29°C and the ambient air temperature at 32°C (although

there is some seasonal variation in air temperature). Basking areas provide extra heat and UV lighting. Natural plants and trees and a visitor walkway provide some seclusion for the *Tomistoma*.

Only 6 months after being moved onto display, mating attempts were observed in January and February 2017. At the end of March, the female began nest site selection and construction, completing it by early April. Interestingly, she constructed her nest very close to the basking area, where substrate surface temperatures were recorded as high as 38°C. This area is also very close to the visitor viewing area - although viewing is from a deck above ground level. The nest was 205 cm x 220 cm x 58 cm high.

On 16 April the female began laying eggs at around 2200 h. The eggs (N= 17) were collected the next morning and placed in incubators. All but two of the eggs showed banding within 24 hours of laying. Average egg size was 90.5 mm (length), 52.7 mm (width) and 154.7 g (weight). Due to paucity of information on temperature-dependent sex determination in *Tomistoma*, we decided to split the clutch and place eggs in separate incubators varying from 30°C to 32.5°C.

The female was very vigilant in defending the nest site throughout the incubation period, remaining either on or near the nest. When in the water, she was always close to and facing the nest, often emerging from the water when visitors were around. This defence behaviour stopped when the nest mound was flattened at the end of the incubation period.

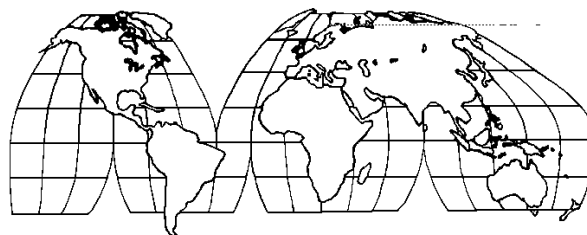
On 17 July 2017, after 92 days of incubation, the first hatchlings emerged. Over the next few days, the remaining eggs hatched out, resulting in 14 hatchlings. Average dimensions of hatchlings were 103.2 g weight (range 98 to 108 g), 338.4 mm TL (range 328 to 347 mm) and 153.4 mm SVL (range 146 to 158 mm). Average growth in TL after the first month was 55.78 mm (range 50 to 78 mm). Average incubation period was 92 days at 32.6°C, 94 days at 32.0°C, 95 days at 31.5°C and 103 days at 29.8°C.

The two largest hatchlings were temporarily placed on display for World *Tomistoma* Day (see page 4), but taken off display soon after. We do not recommend that the young of this species be put on public display too soon. One of the 14 hatchlings failed to thrive, and 13 hatchlings remained as of September 2017. All were feeding well, and growing rapidly.

This is the first time that *T. schlegelii* has been bred in the UK, and as far as we are aware only the second time for any zoo in Europe (the other being Bioparc Fuengirola in Spain). For further details, please contact Shaun Foggett, Director of Crocodiles of the World (shaun.foggett@crocodiles-of-the-world.co.uk).

Colin Stevenson, *Vice Chair, CSG-Tomistoma Task Force* (coleosuchus@hotmail.com).

Regional Reports



Latin America and the Caribbean

Ecuador

The XI Congreso Latinoamericano de Herpetología (XI Latinamerican Herpetology Congress; XILHC) was held in Quito, Ecuador, on 24-28 August 2017. Organizers had previously sent invitations to some CSG members, asking whether they wished to include a crocodilian symposium in the program. Sergio Balaguera-Reina, Alvaro Velasco and Pablo Siroski accepted the invitation, and co-chaired a Crocodilian Symposium titled “Crocodilidos en Latinoamérica: Pasado, Presente y Futuro” (Crocodilians in Latin America: Past, Present and Future). We identified participation at XILHC as a good opportunity to identify a new generation of people with interest to work on crocodilians, and to obtain updates on the progress of actions and issues with local crocodilian species.

There were 18 presentations from various countries in the Latin America and Caribbean region (Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Panama, Venezuela) and the USA, representing a diversity of topics - ecosystem value, genetics, paleontology, morphology, releasing programs, nesting ecology, trade, human-crocodilian conflict, management programs, etc. - and including two plenary lectures by Dr. Perran Ross on IUCN Red Listing for crocodilians in the region, and Dr. Lou Densmore on crocodilian evolutionary biology. Attended by 60+ people, it was an interesting event, with high quality of presentations and different points of view and current concepts.

We also took the opportunity to make some short presentations about the CSG, explaining its mission, how it is organised, how it operates, the student research assistance scheme (SRAS), newsletter, website, etc., and extended an invitation to the next CSG Working Meeting (Argentina, May 2018). We also updated the “old” local and regional contacts and identified young people working with crocodilians who were interviewed and listed as local CSG contacts (formalized by the CSG regional office for Latin America and the Caribbean).

Our visit was also considered an opportunity to have a meeting and introduce ourselves (and the CSG) to national environmental authorities (Biodiversity National Institute and Ministry of Environment), with whom we discussed the current situation in Ecuador with respect to environmental policies and the need for assistance in many situations. We offered CSG expertise to assist in some cases of conflict

between crocodilians and local communities, how to strengthen efforts to improve public education and increase community participation in conservation, increase support for the organization of local crocodilian groups, improve communication with researchers to evaluate management plans, etc. Immediately after the Congress the authorities asked if we could review the Action Plan for *Crocodylus acutus* in Ecuador, which was written in 2006.

In conclusion, we agreed that the objectives of the crocodilian symposium were achieved. Our visit was an important learning experience for CSG regional people, and we realized that CSG needs to participate and/or have a presence in this kind of activity, to assist the CSG to achieve its goals and to identify and involve new students, researchers, NGOs, etc., working with crocodilians.



Figure 1. Speakers at Crocodile Symposium. From left (back): Jhon Jairo Gomez (Colombia), Francisco Villamarin (Ecuador), Iván Sandoval Hernández (Costa Rica), Carolina Reyes Puig (Ecuador), James Perran Ross (USA), Llewellyn D. Densmore III (USA), Brandon Gross (USA), Mark A. Lee (USA), Andrés Rodríguez-Cordero, (Bolivia), Sergio Balaguera-Reina (Colombia), Pablo Siroski (Argentina), Alvaro Velasco (Venezuela), Laura Porras (Costa Rica), Betzaida Rivera-Rivera (Colombia); from left (front): Thomas Vilorio-Lagares (Colombia), Ariel Espinosa-Blanco (Colombia), Nidia Farfan-Ardila (Colombia). Absent: Armando Escobedo-Galván (Mexico). Photograph: Alvaro Velasco.

Pablo A. Siroski (*Regional Chair for Latin America and the Caribbean, Human Resources Development; cocokaima@hotmail.com*), Alvaro Velasco (*Regional Chair for Latin America and the Caribbean, Incentives for Conservation; velascocaiman@gmail.com*) and Sergio Balaguera-Reina (*Regional Vice Chair for Latin America and the Caribbean; sergio.balaguera-reina@ttu.edu*).

South Asia and Iran

India

LEECH INFESTATION IN MUGGER (*CROCODYLUS PALUSTRIS*) IN THE VISHWAMITRI RIVER, GUJARAT, INDIA. The majority of leech species (Phylum Annelida, Class Hirudinida) occur in freshwater environments, with

some species occurring in terrestrial and marine environments (Chandra 1991). Most leeches are “hematophagous” (blood-suckers) and can be found as ectoparasites on terrestrial or aquatic animals, including reptiles.

Observations of ectoparasites on crocodilians have primarily related to leeches, yet few publications have addressed leech parasitism in crocodilians. Recently, Tellez (2013, 2017) reviewed and compiled literature on host-parasite interactions of crocodilians, and listed 12 species of crocodilian as hosts for various species of leech (Table 1).

During a study of the Mugger (*Crocodylus palustris*) population in the Vishwamitri River (Fig. 1), a large Mugger was sighted in the Bhimnath area of Vadodara City, Gujarat, India. The animal was submerged in the water entirely, except for its head and back which were above the water surface. Upon closer examination, with the help of binoculars (8 x 40), I observed an orange-pale green leech, about 6 cm long, adhering to the anterior part of its lower jaw (Fig. 2). Due to the urban environs and large size of the Mugger, it was not possible to catch it for a more thorough examination and collection of the leech for further identification. Due to the turbid water, visibility was limited visibility, and so I was unable to view the body of the animal that was under water for possible leech infestation elsewhere.

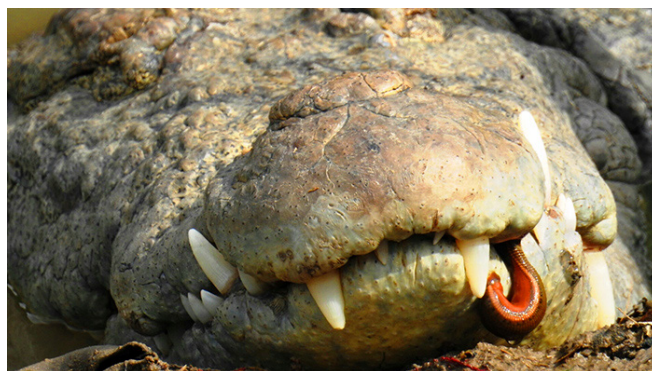


Figure 1. Leech attached to lower jaw of an adult Mugger. Photograph: Rakesh Vadhavan.



Figure 2. Best basking habitat for Muggers on the Vishwamitri River, within the city limits of Vadodara, Gujarat, India. Photograph: Raju Vyas.

The Vishwamitri River is small, flowing east to west through the urban precincts of Vadodara (Fig. 2). It supports a healthy population of Muggers (Vyas 2012). The last ‘croc count’ in January 2015 recorded 229 Muggers of all sizes, ranging from juveniles to full grown adults, all within the 25-km long urban stretch of the Vishwamitri River (R. Vyas, unpublished data).

This river is heavily polluted with urban sewage and waste, but this does not appear to be unfavourable for Muggers (and other aquatic reptiles), and the population has grown within this polluted urban landscape. The river also provides an environment for other organisms such as pathogens and leeches. As per the opinion of Brites and Rantin (2004) and Luiselli *et al.* (2004), organic pollution of streams also sustains leeches; these can cause anemia, favour bacterial and fungal infections, and the transmission of reptilian haemoparasites.

All these ectoparasites are potential vectors for blood parasites (Soifer 1978). However, little is known about the possible pathogenicity of these various species, although leeches could possibly play a role in the transmission of crocodile-specific viral and bacterial infections and be vectors for blood protozoans (Fermino *et al.* 2015).

A significantly higher eosinophilic count in alligators infected with *Placobdella papillifera* was noted as compared to captured animals, which were not leech infected (Glassman *et al.* 1979). Leech infestation may also affect thermal preferences and thermoregulation of crocodiles. Diefenbach (1975) suggested that mouth gaping could possibly have the function of drying and killing ectoparasites. Some of the alligators in this study had large mouth infestations (up to 100 leeches per mouth; numerous inside the upper pits made by the lower teeth).

This is first report of infestation by leeches in Muggers in the Vishwamitri River, and is possibly the first record for the species. This observation incidence prompts us to look in detail and investigate the health of this Mugger population. Moreover, it suggests the need to deploy proper

Table 1. Leech species reported on crocodilians. See also Tellez (2013, 2017).

Crocodilian Species	Leech Species	References
Family Alligatoridae		
<i>Alligator mississippiensis</i>	<i>Philobdella gracilis</i> <i>Placobdella multilineata</i>	Viosca (1962); Huchzermeyer (2003) Smith <i>et al.</i> (1976); Forrester and Sawyer (1974); Johnson <i>et al.</i> (1976); Glassman <i>et al.</i> (1979); Khan <i>et al.</i> (1980); Cooper and Jackson (1981); Cherry and Ager (1982); Jacobson (1984); Brantley and Platt (1991); Huchzermeyer (2003)
	<i>Placobdella papillifera</i> <i>Placobdella siddalli</i> <i>Placobdella nuchalis</i>	Smith <i>et al.</i> 1976; Cooper and Jackson (1981); Huchzermeyer (2003) Richardson <i>et al.</i> (2017) Siddall <i>et al.</i> (2005)
<i>Caiman c. crocodilus</i>	Unidentified	Magnusson (1985); Fermino <i>et al.</i> (2015)
<i>Caiman latirostris</i>	<i>Helobdella</i> sp.	Huchzermeyer (2003)
<i>Caiman yacare</i>	<i>Placobdella</i> sp. <i>Haementeria</i> sp. Unidentified leech	De Almeida <i>et al.</i> (2006) Fermino <i>et al.</i> (2015) Viana and Marques (2005)
Family Crocodylidae		
<i>Crocodylus intermedius</i>	Unidentified	Seijas (2007)
<i>Crocodylus johnstoni</i>	Unidentified	Webb and Manolis (1983); Huchzermeyer (2003)
<i>Crocodylus niloticus</i>	<i>Limnatis nilotica</i> <i>Placobdelloides multistriata</i> <i>Placobdella multilineata</i>	Diesing (1850); Leidy (1884) Leslie <i>et al.</i> (2011) Cott (1961)
<i>Crocodylus novaeguineae</i>	Unidentified	Montague (1984)
<i>Crocodylus porosus</i>	<i>Hirudinaria manillensis</i> <i>Placobdelloides multilineata</i> <i>Placobdelloides stellapapillosa</i>	Jeffrey (1990) Yang and Davies (1985) Govedich <i>et al.</i> (2002); Huchzermeyer (2003)
<i>Crocodylus palustris</i>	Unidentified	this report
<i>Mecistops cataphractus</i>	<i>Placobdelloides multistriata</i> <i>Placobdelloides multilineata</i>	Moore (1938) Moore (1938)
<i>Osteolaemus tetraspis</i>	<i>Placobdelloides multistriata</i>	Moore (1938)
Unidentified crocodile	<i>Hirudinaria manillensis</i>	Huchzermeyer (2003)
Family Gavialidae		
<i>Tomistoma schlegelii</i>	<i>Placobdelloides stellapapillosa</i>	Govedich <i>et al.</i> (2002); Huchzermeyer (2003)

investigation and postmortem procedures, along with detailed histopathology profiles; especially for instances when sudden mysterious death of Muggers are encountered.

Acknowledgments

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Nepal

FIRST CONFIRMED RECORD OF MUGGER CROCODILE (*CROCODYLUS PALUSTRIS*) IN DANG, NEPAL. Nepal is home to two crocodilian species, the Gharial (*Gavialis gangeticus*) and the Mugger (*Crocodylus palustris*) (Maskey 1994; Khadka *et al.* 2008, 2014). The status of the Mugger varies between range states (Nepal, India, Sri Lanka, Bangladesh, Pakistan, Iran), and the global population is listed as Vulnerable on the IUCN Red List (IUCN 2015).

Muggers are relatively common throughout the Terai of Nepal, occurring in marshy lakes, ponds and small rivers (Da Silva and Lenin 2010). The results of a 1993 survey indicated that Muggers were restricted to isolated populations, primarily in protected habitats in Shuklaphanta Wildlife Reserve, and Bardia and Chitwan National Parks. Low numbers of individuals were known or suspected from the Mahakali, Bahuni Nala, Chaudhara, Karnali, Babai, Rapti (Chitwan NP), Narayani and Koshi River systems.

Dang District is located in the western region of Nepal (28°7'0"N, 82°18'0"E), covers an area of 2955 km², and consists of the Dang Valley and Deukhuri Valley. The Babai River is the major waterway of the Dang Valley and the Rapti River is the major river of the Deukhuri Valley, dividing it into southern and northern parts. Within the latter there are 11 village development committees (VDC): Satbariya, Chailahi, Sonpur, Sisahaniya, Lalmatiya on the northern side; and, Rajpur, Bela, Gadawa, Gangapraspur, Gobardhardiya and Koilabas on the southern side. The valley is surrounded by forest-covered hills that connect Bardia, Banke and Chitwan National Parks through the churia forests in the Dovan Bottleneck. The valley is connected to Banke NP in the west and in the south through an intact forest to Sohelwa Wildlife Sanctuary in India (Khanal 2015). The valley lies outside of Nepal's protected area system, but has been identified as one of Nepal's Important Bird Areas by BirdLife International (Baral and Inskipp 2005; Khanal 2015). *Shorea robusta*, *Dalbergia-Acacia* forest are found here, as well as patches of degraded forest.

It is important to note that the name "Rapti" is applied to a number of different rivers in Nepal (eg Chitwan, Makawanpur, Dang and Banke Districts), and this sometimes creates confusion. The Rapti River in Chitwan contains *G. gangeticus* and *C. palustris*, but there is no connection between it and the Rapti River in Dang, around 230 km away. The Rapti River of Dang originates in Pyuthan District mid-hills of Nepal, flows down to Dang, and then towards Banke. The Babai River of Dang has the same name as the Babai River of Bardia, which also contains both species of crocodilian - crocodiles have not

been reported in the Babai River of Dang.

A survey in March-April 2010 of the Rapti River (Dang) did not report any sightings of crocodiles in Dang. A questionnaire survey involving 48 fisherman, boatman and local people near the Rapti River was also carried out - 78% of respondents had seen crocodiles before 2008 and 17% had never seen a crocodile in the Rapti River, and 5% had no idea about crocodiles. In 2011, following flooding in the Rapti and Rihar Rivers, a single hatchling crocodile (species not reported) was found by a 15-year-old student who handed it to his school teacher, who released it into the river (Laxmi Chaudhary, pers. comm.).

Between 2010 and 2015 various surveys were done to confirm the presence/absence of crocodiles in Dang but no evidence was recorded. In 2014, information from local people around Rihar khola suggested the presence of crocodiles. Six attempts were subsequently made from 2014 to 2015 to confirm this information, but no crocodiles were sighted.

In January 2016 a single Mugger (around 1.9 m TL) was recorded basking in the Rihar River (Fig. 1), a small stream that comes from the churia hills of the Deukhuri Valley and mixes with the Rapti River in the south. The specific area in which the crocodile was located is the only part of the Rihar River where deep water occurs throughout the year.



Figure 1. First confirmed Mugger in Dang District.

The crocodile was about 1.5 km from the Rapti River, and represents the first confirmed sighting of the species in Dang. The closest population of Muggers is Kusum (Rapti River) of Banke District, around 27 km from the Rihar River (three crocodiles were recently reported in Kusum; K.B Thapa, pers. comm.). It is possible that crocodiles migrate between these two rivers.

The establishment of Banke NP in 2010 has played a significant role in the conservation of aquatic biodiversity of Banke, but the part of the Rapti River in Dang does not fall in any protected areas, so threats for aquatic fauna are high there - including fishing using baits, chemicals and toxic leaves and bark of plants, explosives and electro-fishing.

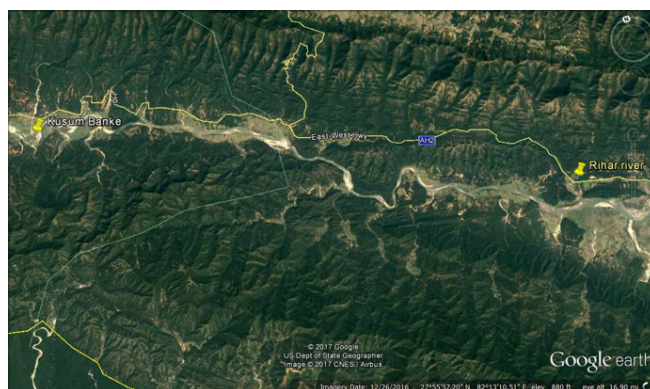


Figure 2. Site of Mugger sighting (Rihar River, Dang District) relative to the nearest Mugger crocodile population (Kusum, Banke District).

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Science



Recent Publications

Weinreich, S.J. (2015). Thinking with crocodiles: An iconic animal at the intersection of early-modern religion and natural philosophy. *Early Sci. Med.* 20(3): 209-40.

Abstract: This paper seeks to explore how culturally and religiously significant animals could shape discourses in which they were deployed, taking the crocodile as its case study. Beginning with the textual and visual traditions linking the crocodile with Africa and the Middle East, I read sixteenth- and seventeenth-century travel narratives categorizing American reptiles as “crocodiles” rather than “alligators,” as attempts to mitigate the disruptive strangeness of the Americas. The second section draws on Ann Blair’s study of “Mosaic Philosophy” to examine scholarly debates over the taxonomic identity of the biblical Leviathan. I argue that the language and analytical tools of natural philosophy progressively permeated religious discourse. Finally, a survey of more than 25 extant examples of the premodern practice of displaying crocodiles in churches, as well as other crocodilian elements in Christian iconography, provides an explanation for the ubiquity of crocodiles in Wunderkammern, as natural philosophy appropriated ecclesial visual vocabularies.

Eam, S.U., Sam, H., Hor, L., Mizrahi, M. and Frechette, J.L. (2017). Movement of captive-reared Siamese crocodiles *Crocodylus siamensis* released in the Southern Cardamom National Park, Cambodia. *Cambodian Journal of Natural History* 2017(1): 102-108.

Abstract: Once widely distributed throughout Southeast Asia, the Siamese crocodile *Crocodylus siamensis* is currently one of the world’s most Critically Endangered crocodilian species. Because Cambodia is home to the largest remaining wild population, conservation efforts within the country should be considered of upmost importance. This study was aimed to understand the movement and survival of captive-reared Siamese crocodiles released as a part of a national reintroduction and reinforcement program. In the study, 15 juvenile and sub-adult crocodiles fitted with VHF radio transmitters were monitored for up to 18 months after release in the Southern Cardamom National Park, southwestern Cambodia. Thirteen of the crocodiles were detected within 700 m of the release site during monitoring, which occurred mostly during the dry season. Their sedentary behaviour was consistent with previous studies of young Siamese crocodiles in the Cardamom Mountains. Remaining close to release sites may be beneficial for crocodiles by reducing chances of their moving to more marginal habitats or areas where conflict could potentially occur with people.

Brien, M.L., Gienger, C.M., Browne, C.A., Read, M.A., Joyce, M.J. and Sullivan, S. (2017). Patterns of human-crocodile conflict in

Queensland: a review of historical estuarine crocodile (*Crocodylus porosus*) management. *Wildlife Research* 44(4): 281-290.

Abstract: In Queensland, the management of estuarine crocodiles (*Crocodylus porosus*) by the government is important for ensuring public safety, especially along the populated east coast, where there is a large human population. The present study aimed to determine historical, temporal and spatial patterns of human-crocodile conflict in Queensland. The study used Queensland Government records of estuarine crocodile attacks (1971-2015), sightings by the general public (2003-2015), and removals and relocations for management purposes (1985-2015) to develop General Linear Models describing historical, temporal and spatial patterns. The highest number of attacks, sightings, removals and relocations occurred along the populated east coast between Townsville and the Daintree during wet season months (November-February). There have been 35 crocodile attacks in Queensland since 1971 (total 0.8 per year; fatal 0.3 per year), mostly involving local people or regular visitors (77.1%), specifically adult males (71.4%; mean age 44). There has been an increase in the rate of crocodile attacks over time, with an average of 1.3 per year since 1996, most of which were non-fatal (84%). The number of crocodile sightings has been increasing annually (with a mean of 348 per year since 2011), while the number of crocodiles removed or relocated for management purposes (n = 608) has fluctuating widely each year (range 1-57). The level of human-crocodile conflict in Queensland is increasing, and this is likely to be a consequence of increasing human and crocodile populations. While conflict is highest during the wet season, estuarine crocodiles pose a threat to public safety year round. With the increase in conflict, the ongoing management of estuarine crocodiles, through targeted removals in and around areas of higher human habitation and through education, is essential for ensuring public safety into the future.

Sinovas, P., Price, B., King, E., Hinsley, A. and Pavitt, A. (2017). Wildlife trade in the Amazon countries: An analysis of trade in CITES listed species. Technical report prepared for the Amazon Regional Program (BMZ/DGIS/GIZ). UN Environment-World Conservation Monitoring Centre: Cambridge, UK.

Abstract: The 8 South American countries subject of this analysis (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela) enjoy an extremely diverse range of wildlife, encompassing species native to the Amazon basin, but also native to other ecoregions within the countries, such as the Andes, Cerrado, Llanos or the Atlantic Forest, amongst others. This biodiversity includes over 12,000 species listed in the Appendices to the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), the majority in Appendix II. This report presents the first comprehensive overview of international trade in CITES-listed wildlife in the 8 countries above, which cooperate at the regional level as members of the Amazon Cooperation Treaty Organization (ACTO). The analysis provides a baseline of information on trade levels and trends in the 8 countries, based on data from their CITES annual reports for the 10-year period 2005-2014, in order to inform trade management in the region. An overview is presented in section 2 of the report, with more detailed country-level overviews provided in section 3. Trade in CITES-listed species from the region during 2005-2014 involved primarily native species listed in CITES Appendix II. In particular: caiman and peccary skins and vicuña fibre for the fashion industry; live reptiles for the pet market; live orchids and live arapaima fish for ornamental purposes; caiman, arapaima and queen conch meat for the food industry; sea cucumbers for food and traditional medicine; and Spanish cedar and big-leaf mahogany products for the timber industry. As part of this analysis, 8 case studies are considered in more depth: mammals, parrots, caiman products, live reptiles, frogs, arapaima, orchids and timber. Key findings from these case studies include: Spectacled caiman (*Caiman crocodilus*) skins represented the largest volume of CITES-listed commodities exported from the region. On average, around 770,000 skins were exported per year over the 10-year period for the fashion industry, mainly as captive-

bred from Colombia, but with smaller amounts of captive-bred exports also from Brazil and wild-sourced exports from Bolivia, Guyana and Venezuela. The main importers were Singapore, Mexico and Thailand. Caiman skin exports experienced a dip during 2008-2009, possibly as a result of the global financial crisis in those years. Caiman meat, often a by-product of the skin industry, was also exported from the region, albeit only during 2005-2007 from Bolivia and Colombia (mainly to Belgium, the United States and China), as the infrastructure and logistical requirements to meet international food safety standards presented challenges for the continuation of this enterprise. Exports of live reptiles, chiefly for the pet market, included turtles, lizards, snakes and caimans. The total financial value of CITES-listed exports from the region (based on declared import prices and global retail websites, for plants) is estimated to be \$US128 million per year on average (\$US1.3 billion over the 10-year period). The trade in individual taxa with the highest estimated value related to caiman skins (\$US50 million per year) and timber (\$US35 million per year), followed by peccary skins (\$US7 million per year), live reptiles (\$US6 million per year), live parrots (\$US5 million per year) and orchids (\$US3 million per year). It is important to note that the socio-economic importance of the trade may be amplified at local scales and go beyond its international financial value. The analysis also highlights species showing noteworthy trade trends (high volume and/or sharp increase in trade) based on criteria equivalent to those used to inform the CITES Review of Significant Trade process. Cases that may need further consideration are noted in section 5, including parrots and reptiles from Guyana and Suriname, amongst other. In addition, the report identifies species native to Amazonian countries that were exported from other countries, both as wild-sourced and captive-bred or artificially-propagated, highlighting those that are endemic to a single Amazonian country. Implications for conservation, benefit sharing, knowledge transfer and understanding of sustainable use potential are discussed. Recommendation arising from the report, including on reporting of trade data, management and conservation considerations, and topics for future work are outlined in section 7 of the report.

Tsakona, V. (2017). Constructing local identities via/for humour: A Cretan-Greek case study. *Styles of Communication* 9(2): 118-147.

Abstract: One of the most common functions of humour is the construction of identity, usually achieved by including certain individuals in a group sharing specific values and views, and by excluding others representing different values and views (Archakis and Tsakona 2005). The aim of the present study is to investigate how online interactants create a local identity via the production of digital humorous texts, thus forming a group of people with common perceptions on a specific event reported by the media. In particular, Facebook participants formed communities supporting the right of a crocodile - non endemic to Greece - to live on the loose in a lake in Crete, Greece, and opposing local authorities wishing to capture the animal. Interlocutors draw on, and reframe, popular - and even stereotypical - aspects of the Cretan identity involving, among other things, a passionate love of freedom, resistance to official authorities, rebelliousness, and heroism (Herzfeld 1985). Such cultural traits seem to be attributed to the crocodile so as not only to bolster the interlocutors' own perspective, but also to create a humorous effect.

Merchant, M., McAdon, C., Mead, S., McFatter, J., McMahan, C.D., Griffith, R. and Murray, C.M. (2017). Comparison of serum phospholipase A₂ activities of all known extant crocodylian species. *Advances in Biological Chemistry* 7: 151-160.

Abstract: Serum samples from all 23 extant crocodylian species were tested for phospholipase A₂ (PLA₂) activity against nine different bacterial species. The data were used to generate a PLA₂ activity profile for each crocodylian species, and the data were used to compare the activities of the three main lineages (Alligatoridae,

Crocodylidae, and Gavialidae), the seven different genera, and to compare all of the 23 individual species. The data revealed that the three lineages of crocodylians (Alligatoridae, Crocodylidae, and Gavialidae) exhibited PLA₂ activities toward 9 species of bacteria that were statistically distinguishable. In addition, the PLA₂ activities of crocodylians in a specific genus tended to be more similar to other members in their genus than to members of other crocodylian genera.

Das, C.S. and Jana, R. (2017). Human-crocodile conflict in the Indian Sundarban: an analysis of spatio-temporal incidences in relation to people's livelihood. *Oryx* (doi: <https://doi.org/10.1017/S0030605316001502>).

Abstract: The incidence of human-crocodile conflict is increasing, and fear of injury and loss of life is affecting public and political support for crocodile conservation. We studied conflicts between people and estuarine crocodiles *Crocodylus porosus* across socio-economic dimensions, using a spatio-temporal database. We collected data on 127 crocodile attacks that occurred during 2000-2013, through questionnaires including open- and close-ended questions, administered in 30 villages of five blocks of the Indian Sundarban. Most of the attacks (42%) occurred during winter (December-February), followed by the early monsoon (May-July; 27%). Almost 80% of victims were prawn seed collectors and were 11-50 years old, and 61.16% of victims died as a result of the attacks. Female victims accounted for a higher percentage of deaths (55.12%) than male victims (44.88%). Crocodile attacks were more common in the daytime than at night, with 76.35% of the killings occurring during 08.00-17.00. Most of the cases were recorded from Gosaba (34%), followed by Patharpratima (25.24%) and Namkhana (18.45%) blocks. The mean number of incidents per year was 9.07, with vulnerability and mortality rates of 0.07 and 0.04, respectively, per 10,000 persons. Existing management practices are insufficient to eliminate the risk of crocodile attacks and ensure the conservation of the Sundarban ecosystem. A comprehensive management plan for reducing dependency on forest resources is needed to minimize human-crocodile conflict.

Cook, A.C., Tran, V.-H., Spicer, D.E., Rob, J.M.H., Sridharan, S., Taylor, A., Anderson, R.H. and Jensen, B. (2017). Sequential segmental analysis of the crocodylian heart. *Journal of Anatomy* (doi: 10.1111/joa.12661).

Abstract: Differences between hearts of crocodylians and those of mammals and birds are only partly understood because there is no standardised approach and terminology for describing cardiac structure. Whereas most reptiles have an undivided ventricle, crocodylians have a fully septated ventricle. Their hearts, therefore, are more readily comparable with the hearts of mammals and birds. Here, we describe the heart of a crocodile (*Crocodylus niloticus*). We use the versatile sequential segmental approach to analysis, juxtaposing several key views of the crocodylian heart to the comparable views of human hearts. In crocodiles, the atrial and ventricular septums are complete but, unlike in placental mammals, the atrial septum is without an oval fossa. The myocardial component of the crocodylian ventricular septum dominates, but the membranous septum likely makes up a greater proportion than in any mammal. In the crocodile, the aortic trunk takes its origin from the left ventricle and is not wedged between the atrioventricular junctions. Consequently, there is a common atrioventricular junction, albeit with separate right and left atrioventricular valvar orifices. As in mammals, nonetheless, the crocodylian left atrioventricular valvar orifice is cranial to the right atrioventricular valvar orifice. By applying a method of analysis and terminology usually restricted to the human heart, we build from the considerable existing literature to show neglected and overlooked shared features, such as the offset between the left and right atrioventricular valvar orifices. Such commonalities are surprising given the substantial evolutionary divergence of the archosaur and synapsid lineages, and likely reflect evolutionarily shared morphogenetic programmes.

Cissell, J.R. (2017). Habitat-level mapping of mangrove cover trends in Ciénaga de Zapata, Cuba, using landsat imagery and local knowledge. MSc thesis, University of Alabama, Tuscaloosa, Alabama, USA (<http://ir.ua.edu/handle/123456789/3222>).

Abstract: The mangrove forests of Ciénaga de Zapata, Cuba, are of critical importance from both biodiversity and ecosystem service perspectives. The peninsula is home to more than 1000 invertebrate species, more than 80% of the island's total bird species, and numerous fish, mammals, and reptiles, including the Cuban crocodile (*Crocodylus rhombifer*) and Cuban gar (*Atractosteus tristoechus*), two species found only in Cuba. Zapata's mangroves also support populations of sport and commercial fish such as bonefish (*Albula vulpes*), tarpon (*Megalops atlanticus*), permit (*Trachinotus falcatus*), and snook (*Centropomus undecimalis*). Despite the ecological importance of Zapata's mangroves, no published work has documented any changes in the forests' extent or distribution throughout the past two decades. This project combined unsupervised classification and visual interpretation of Landsat imagery with local knowledge to quantify and map area changes in Zapata's mangrove forests from 1994 to 2014. Habitat zones mapped by local stakeholders were used to measure and compare mangrove change at the scale of individual species' preference areas. Study results demonstrated a negligible (1.20%) decrease in total mangrove area during the study period. However, changing socio-political and economic dynamics between the United States and Cuba could precipitate rapid development along nearby coastal locations in the near future, and these results provide necessary baseline information against which to measure future pressures on Zapata's mangroves at the cusp of a period of potentially substantial future change.

Farlow, J.O., Robinson, N.J., Kumagai, C.J., Paladino, F.V., Falkingham, P.L., Elsey, R.M. and Martin, A.J. (2017). Trackways of the American Crocodile (*Crocodylus acutus*) in Northwestern Costa Rica: Implications for crocodylian ichnology. Ichnos (<http://dx.doi.org/10.1080/10420940.2017.1350856>).

Abstract: We documented trackways of free-living *Crocodylus acutus* on beaches at the mouths of Tamarindo and Ventanas estuaries, Costa Rica. Our crocodiles had estimated total lengths of 1-3 m or more. Manus prints have five digits, with digits I-III bearing claw marks. Pes prints have four digits, with claw marks on digits I-III. The pes is plantigrade. Claws generally dig into the substrate. Apart from claw marks, digit I and the heel of the pes are usually the most deeply impressed parts of footprints. Trackways are wide-gauge. Pes prints are usually positioned just behind ipsilateral manus prints of the same set and may overlap them. Manus and pes prints angle slightly outward with respect to the crocodile's direction of movement. Claw-bearing digits of both the manus and pes may create curved, concave-toward-the-midline drag marks as the autopodium is protracted. The tail mark varies in depth and clarity, and in shape from nearly linear to markedly sinuous. Sometimes the tail mark hugs the trackway midline, but sometimes it is closer to, or even cuts across, prints of one side. American crocodile footprints and trackways are similar to those observed in other extant crocodylian species, indicating substantial trackway conservatism across the group.

Merchant, M., Morkotinis, V., Hale, A., White, M. and Moran, C. (2017). Crocodylian nuclear factor kappa B. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 213: 28-34.

Abstract: We deduced the amino acid (aa) sequence of the nuclear factor kappa B (NF κ B) protein from genomic data for the American alligator (*Alligator mississippiensis*), the estuarine crocodile (*Crocodylus porosus*), and the Indian gharial (*Gavialis gangeticus*). A 105 kDa protein, NF κ B1 exhibits complex post-translational processing, multiple mechanisms of activation, and acts as precursor for a p50, a Rel homology transcription factor which influences the

expression of key genes for developmental processes, apoptosis, and immune function. The aa sequences of the crocodylian proteins share very high identity with each other ($97.2 \pm 0.7\%$), birds ($81.0 \pm 1.1\%$, $n=6$), mammals ($75.3 \pm 1.6\%$, $n=4$), reptiles ($80.3 \pm 5.1\%$, $n=2$), and less identity with fish ($55.5 \pm 5.5\%$, $n=4$) and one amphibian ($66.1 \pm 0.8\%$). The crocodylian protein has a well-conserved Rel homology domain, a nuclear localization signal, and a glycine-rich region which facilitates proteasome-mediated generation of p50. The Rel homology domain contains sequences responsible for dimerization, DNA-binding, and nuclear translocation. In addition, seven ankyrin repeats were located, which putatively allow for inhibition of transcriptional regulation by mediating interaction with Inhibitor kappa B. Other features include a death domain, and conserved serine residues, near the C-terminal end, which act as potential phosphorylation sites for activation of the proteolytic generation of p50. Western blot analysis showed both the 105 kDa precursor and the 50 kDa mature NF κ B were expressed in the alligator liver. Nuclear factor κ B exhibited diffuse cytoplasmic distribution in alligator hepatocytes, and almost no cytoplasmic localization in infected animals. In addition, nuclear NF κ B exhibited specific binding to the consensus NF κ B promoter element.

Edwards, G.P., Webb, G.J.W., Manolis, S.C. and Mazanov, A. (2017). Morphometric analysis of the Australian freshwater crocodile (*Crocodylus johnstoni*). Australian Journal of Zoology (doi.org/10.1071/ZO16079).

Abstract: We conducted a morphometric analysis of 279 *Crocodylus johnstoni*, using specimens from the McKinlay River ($n=265$) and Arnhem Land ($n=14$), to meet the management need for predicting body size of *C. johnstoni* from isolated body parts. The results also allow reconstruction of *C. johnstoni* dimensions for comparison with other crocodylian species. We detected sexual dimorphism in some body measurements from the McKinlay River, and geographic variation in the morphology of McKinlay River and Arnhem Land populations, but differences were slight. There is pronounced allometric growth in *C. johnstoni* in the immediate post-hatching phase, largely due to elongation of the snout after exiting the confines of the egg. We compared the size, shape and relative growth of *C. johnstoni* with that of other crocodylian species for which equivalent data are available, but particularly the other Australian crocodile, *C. porosus*. *Crocodylus porosus* has a proportionately longer tail and a shorter but wider snout than *C. johnstoni*, and we discuss possible ecological correlates of these and other differences.

Jeyamogan, S., Khan, N.A. and Siddiqui, R. (2017). Animals living in polluted environments are a potential source of anti-tumor molecule(s). Cancer Chemotherapy and Pharmacology (<https://doi.org/10.1007/s00280-017-3410-x>).

Abstract: Despite advances in therapeutic interventions and supportive care, the morbidity and mortality associated with cancer have remained significant. Thus, there is a need for newer and more powerful anti-tumor agents. The search for new anti-tumor compounds originating from natural resources is a promising research area. Animals living in polluted environments are a potent source of anti-tumor agents. Under polluted milieus, species such as crocodiles, feed on rotten meat, are exposed to heavy metals, endure high levels of radiation, and are among the very few species to survive the catastrophic Cretaceous-Tertiary extinction event with a prolonged lifespan. Thus, it is reasonable to speculate that animals such as crocodiles have developed mechanisms to defend themselves against cancer. The discovery of antitumor activity in animals such as crocodiles, whales, sharks, etc., will stimulate research in finding therapeutic molecules from unusual sources, and has potential for the development of novel antitumor compound(s) that may also overcome current drug resistance. Nevertheless, intensive research in the next few years will be required to realize these expectations.

Wang, L., Dong, C., Li, X., Han, W. and Su, X. (2017). Anticancer

potential of bioactive peptides from animal sources. *Oncology Reports* (<https://doi.org/10.3892/or.2017.5778>).

Abstract: Cancer is the most common cause of human death worldwide. Conventional anticancer therapies, including chemotherapy and radiation, are associated with severe side effects and toxicities as well as low specificity. Peptides are rapidly being developed as potential anticancer agents that specifically target cancer cells and are less toxic to normal tissues, thus making them a better alternative for the prevention and management of cancer. Recent research has focused on anticancer peptides from natural animal sources, such as terrestrial mammals, marine animals, amphibians, and animal venoms. However, the mode of action by which bioactive peptides inhibit the proliferation of cancer cells remains unclear. In this review, we present the animal sources from which bioactive peptides with anticancer activity are derived and discuss multiple proposed mechanisms by which these peptides exert cytotoxic effects against cancer cells.

Bradford, C. and Eschenbrenner, M. (2017). Health survey including selected blood parameters in the African Slender Snouted Crocodile (*Mecistops cataphractus*) at the Abidjan Zoo in Cote d'Ivoire. *Journal of Zoo and Wildlife Medicine* 48(2): 510-513.

Abstract: The Zoo National d'Abidjan (Abidjan Zoo) in Côte d'Ivoire, West Africa, holds the world's largest captive population of African slender-snouted crocodiles (*Mecistops cataphractus*, formerly *Crocodylus cataphractus*), at 36 adults, 16 yearlings, and 23 hatchlings. Twelve yearling and 12 adult slender-snouted crocodiles at the Abidjan Zoo were restrained for physical exam, body condition scoring, and venipuncture in September 2015. Blood samples collected from the supravertebral venous sinus were analyzed using a handheld blood analyzer (Abaxis® I-stat, Abaxis, Inc., Union City, California 94587, USA) with Chem8+ cartridges (CLIAwaived, Inc., San Diego, California 92130, USA). The adult crocodiles appeared in good general health and demonstrated blood values similar to those of other reptiles. The yearlings had low, ionized calcium values and low hematocrit and hemoglobin levels compared with the adult crocodiles and to other crocodile reference ranges. These findings may dramatically improve the health of the crocodiles and help to ensure a thriving captive population of this critically endangered species.

Cervantes, O., Olivos-Ortiz, A., Anguiano-Cuevas, R., Contreras, C. and Chávez-Comparan, J.C. (2017). Implementation of a Wildlife Management Unit as a sustainable support measure within the Palo Verde Estuary, Mexico: Example of the American Crocodile (*Crocodylus acutus*). Pp. 555-572 in *Coastal Wetlands: Alteration and Remediation*. Coastal Research Library, Vol. 21, ed. by C. Finkl and C. Makowski. Springer: Cham.

Abstract: It is recognized that pollution, fragmentation of ecosystems and habitat destruction due to human activities, make necessary the sustainable use of natural resources ensuring a balanced development with legal certainty by alternatives that promote the protection, preservation and proper use of natural resources. Mexico is not the exception, the Palo Verde Estuary is a RAMSAR site that supports various socio-economic activities, and has a tendency towards deterioration. It has been the focus of many environmental studies. This paper describes the implementation of a Wildlife Management Unit for sustainable commercial harvesting of crocodile *Crocodylus acutus* as an alternative project in the site known as Ecological Center Tortugario of Cuyutlan. Thus, providing a standard for integrating an economic aspect to biodiversity and ecosystem protection in the decision making process. Finally, an analysis is made from the perspective of conceptual framework Driving Forces-Pressure-State-Impact-Response where the institutional context and participative management can be the main support of sustainable development on this site. The expansion of the a Wildlife Management Unit is an alternative project for the sustainable use of *C. acutus* present in the Palo Verde Estuary that can be replicated in

other Mexican coastal systems. Additionally, in itself it represents an opportunity to reconcile human activities with the environment.

Ahmad, A.A., Dorrestein, G.M., Oh, S.J.W.Y. and Hsu, C.D. (2017). Multi-organ metastasis of fibrolamellar hepatocellular carcinoma in a Malayan Gharial (*Tomistoma schlegelii*). *Journal of Comparative Pathology* 157(2-3): 80-84.

Abstract: A 38-year-old Malayan Gharial (*Tomistoma schlegelii*) with a 2-week history of anorexia was found dead and presented for post-mortem examination. Numerous white firm nodules of various sizes were found on the surface of the liver, both left and right kidneys, the spleen and the serosa of the intestinal tract. All masses had similar microscopical appearance and were diagnosed as metastasizing fibrolamellar hepatocellular carcinoma. Immunohistochemically, the tumour cells did not react with antibodies specific for pan-cytokeratin, vimentin or HepPar-1. The anti-HepPar-1 and anti-pan-cytokeratin antibodies also did not react with normal hepatocytes or exocrine pancreatic cells. This is the first description of fibrolamellar hepatocellular carcinoma with metastases in a crocodilian.

Scheepers, S. (2017). *Luxury Value Perceptions that Drive South African Female Consumers' Purchase Intent for Luxury Exotic Leather Accessories*. MConsumer Science thesis, University of Pretoria.

Abstract: The study investigated South African female consumers' purchase intent for luxury exotic leather accessories, with specific reference to exotic crocodile leather, as well as their perceived values of luxury exotic leather products and brands. A survey was conducted across South Africa that included representation of the following ethnic groups: African, White, Coloured, Asian and Indian. All the individuals surveyed were female. Consulta Research, a consumer research company, assisted the research study in collecting data. Data was collected by means of a non-probability convenient sampling method. Consulta Research distributed an online questionnaire to female participants on their database. Three hundred and thirty seven (337) usable questionnaires were completed and returned. Data analysis consisted of descriptive statistics, exploratory factor analysis, Spearman's correlation analysis and Cohen's d correlation analysis. All of the demographic and lifestyle characteristics were useful in describing the South African female consumer. The findings indicated that the majority of the respondents were not willing to spend market-related prices for genuine crocodile leather accessories. The study confirmed that luxury value perceptions may include five dimensions that are distinguished in literature, namely Social, Individual gifts, Individual pleasure, Financial, and Functional value perceptions. Functional value perceptions were found to be more important to South African respondents, although previous studies in other countries have shown that Social and Individual value perceptions are more important. According to the literature presented in the study, it was confirmed that purchasing intent is part of the decision-making process, since intention is evident in an individual's readiness to perform a given behaviour. The findings showed that South African female respondents have a weak Purchasing intent for exotic crocodile leather accessories. The study, however, also showed that in the future at some point a substantial percentage of respondents might buy (24.00% + 18.60% + 20.70%), have the intention to buy (23.40% + 17.50% + 21.30%) and have an interest to buy (23.10% + 17.80% + 18.90%) an exotic crocodile leather accessory. A high practical significance was also found for the correlation between Purchasing intent and Functional value perceptions. This might be an indicator of the important role that functionality would play in respondents' final decision to buy or not buy an exotic crocodile leather accessory. This has implications for industry stakeholders because Functional value perceptions, according to the study, can be described as superior quality, quality assurance, high quality standards and substantive attributes and performance factors. Therefore industry stakeholders within the luxury exotic crocodile leather industry, be it suppliers, manufacturers, breeders, farmers, retailers or marketers,

should take these consumer values into consideration in order to maximise the ultimate value delivered by the supply chain. Various recommendations are made based on the findings of this study, to either expand or build onto this existing research. Topics related to luxury exotic crocodile leather accessories and luxury consumers in South Africa can definitely be explored further to fill the current gap in knowledge in this field.

Langoya, D.A.C. (2017). The Role of Bushmeat in Household Food Security : A Case Study in Central Equatoria State, South Sudan. MSc thesis, Norwegian University of Life Sciences, As, Norway.

Abstract: The study was done to understand the role of bushmeat for households' food security in the Central Equatoria State of South Sudan. A sample of 100 households were interviewed using a quantitative survey method, to assess the amount of their monthly consumption of bushmeat, frequency of consumption, income generated from bushmeat sale and challenges faced in using bushmeat as a food resource. The collected data were analyzed using SPSS software version 20. The result showed that the most eaten bushmeat was wild mammals, followed by birds and insects. The majority of respondents did not consume reptiles, but a low rate of consumption of crocodile and python was documented. In terms of the type of bushmeat hunted, the most hunted bushmeat species were antelopes: Bohor reedbuck (*Redunca redunca*), Mongalla gazelle (*Gazella rufifrons albonotata*) and warthog (*Phacochoerus africanus*), followed by rodents (rats, porcupines and hares). Few hunted Hippopotamus (*Hippopotamus amphibius*) and a respondent who hunts more than two types of mammals mentioned reticulated giraffe (*Giraffa camelopardalis*). The amount of bushmeat consumed/kg/month was significantly higher when compared with livestock's meat (Cattle meat, goat meat and sheep meat). When compared with other food types, although it was lower than the amount of cereals and green vegetables consumed, still the quantity of bushmeat consumed was higher than the quantity of chicken and fish. Regarding the frequency of hunting between and within seasons, hunting for bushmeat was generally done seasonally and especially during the dry season. Concerning the contribution of bushmeat to households' income, on average bushmeat generated significantly higher income per month compared to other sources of income like charcoal making, firewood collection and salaries of the unclassified staffs (Unprofessional Staffs). The majority of respondents used the money generated from sales of bushmeat for buying additional food, and for paying children's school fees. Regarding the challenges for using bushmeat as a food resource, the challenges included insecurity, wildlife laws, lack of men in the family and harmful animals. 42.58% of the interviewees reported insecurity as the most challenging threat to hunting. It generally shows that bushmeat is very important for the food security and income of the households studied.

Katsu, Y., Oka, K. and Baker, M.E. (2017). Evolution of steroid specificity in human, chicken, alligator, frog and zebrafish mineralocorticoid receptors: Allosteric interactions affect steroid specificity. bioRxiv (doi: <https://doi.org/10.1101/151233>).

Abstract: We studied the response to aldosterone, 11-deoxycorticosterone, 11-deoxycortisol, cortisol, corticosterone, progesterone, 19-norprogesterone and spironolactone of human, chicken, alligator, frog and zebrafish full-length mineralocorticoid receptors (MRs) and truncated MRs, lacking the N-terminal domain (NTD) and DNA-binding domain (DBD), in which the hinge domain and ligand binding domain (LBD) were fused to a GAL4-DBD. Compared to full-length MRs, some vertebrate MRs required higher steroid concentrations to activate GAL4-DBD-MR-hinge/LBD constructs. For example, 11-deoxycortisol activated all full-length vertebrate MRs, but did not activate truncated terrestrial vertebrate MRs and was an agonist for truncated zebrafish MR. Progesterone, 19-norprogesterone and spironolactone did not activate full-length and truncated human, alligator and frog MRs. However, at 10 nM, these steroids activated full-length chicken and zebrafish MRs; at

100 nM, these steroids had little activity for truncated chicken MRs, while retaining activity for truncated zebrafish MRs, evidence that regulation of progestin activation of chicken MR resides in NTD/DBD and of zebrafish MR in hinge-LBD. Zebrafish and chicken MRs contain a serine corresponding to Ser810 in human MR, required for its antagonism by progesterone, suggesting novel regulation of progestin activation of chicken and zebrafish MRs. Progesterone may be a physiological activator of chicken and zebrafish MRs.

Moyle, B. (2017). Wildlife markets in the presence of laundering: a comment. Biodiversity and Conservation (doi:10.1007/s10531-017-1396-7).

Abstract: Bans on the trade in wildlife are advocated as means to reduce poaching and the illegal sales of wildlife products. One of the rationales for such bans is to prevent laundering. Laundering occurs when illegal wildlife products are passed off as legal, and sold in legal outlets. Nonetheless, wildlife trade has also reduced poaching for other species via competition from legal traders against illegal. These opposing laundering and competition effects are reconciled in a general trade model. This shows that there is a trade-off between laundering and competition, leading to a legal market whose size optimises these two effects. Where illegal sales are occurring largely outside the legal market, trade bans have limited effect. Bans are most effective when the scale of laundering dominates all other trade.

Dal Sasso, C., Pasini, G., Fleury, G. and Maganuco, S. (2017). *Razanandrongobe sakalavae*, a gigantic mesoeucrocodylian from the Middle Jurassic of Madagascar, is the oldest known notosuchian. PeerJ 5:e3481.

Abstract: *Razanandrongobe sakalavae* Maganuco, Dal Sasso & Pasini, 2006 is a large predatory archosaur from the Middle Jurassic (Bathonian) of the Mahajanga Basin, NW Madagascar. It was diagnosed on the basis of teeth and a fragmentary maxilla, but its affinities were uncertain. Here we describe new cranial remains (above all, an almost complete right premaxilla and a caudally incomplete left dentary) that greatly improve our knowledge on this enigmatic species and reveal its anatomy to be crocodylomorph. The right premaxilla indicates that the rostrum was deep, wide, and not pointed; it bears five teeth that are sub-vertical and just slightly curved lingually; the mesial teeth are U-shaped in cross-section and have serrated carinae on the lingual side; the apertures nasi osseae (external bony nares) are confluent and face rostrally; and there is no lateral groove at the premaxillomaxillary suture for reception of a hypertrophied lower caniniform tooth. The preserved portion of the left dentary has an edentulous tip and bears eight large mandibular teeth of which the mesial (1-3) are the largest, but none is a hypertrophied caniniform tooth; the mandibular (dentary) symphysis extends caudally to the level of the third tooth; the splenial is not preserved, but its sutural marks on the dentary indicate that it contributed to the mandibular symphysis for at least 20% of the symphyseal length in dorsal aspect. On the basis of this new data, some previously uncertain features of the holotype maxilla - such as the margin of the suborbital fenestra, the contact surfaces for the palatine, the ectopterygoid, and the jugal - are now apparent. Testing of the phylogenetic position of the species within Crocodylomorpha indicates that *R. sakalavae* is a mesoeucrocodylian. It also represents one of the earliest events of exacerbated increase in body size along the evolutionary history of the group. In addition, it is by far the oldest notosuchian. A cranial reconstruction of this gigantic predator is also attempted here. The very robust jaw bones of *R. sakalavae*, coupled with its peculiar dentition, strongly suggest a diet that included hard tissue such as bone and tendon.

Zhang, S.-Z., Meng, T., Khu, X., Wang, H., Zhou, Y.-K. and Wu, X.-B. (2017). Molecular characterization and tissue expression profiles of prepro-vasoactive intestinal peptide in the Chinese alligator (*Alligator sinensis*) during the active and hibernating periods. JEZ-A

Abstract: The Chinese alligator (*Alligator sinensis*), a freshwater crocodilian endemic to China, is one of the most endangered crocodilian species; up to this date, very little is known about the endocrine regulation of its metabolic activities during different physiological states. In this study, we characterized the structure of the prepro-vasoactive intestinal peptide in Chinese alligator (prepro-caVIP) for the first time and examined its expression profiles in various tissues during the active and hibernating periods. The prepro-caVIP cDNA consists of a 221-bp 5'-untranslated region (UTR), a 606-bp complete coding region (CDS), and a 312-bp 3'-UTR, which encodes the 201-amino acid prepro-caVIP containing a 28-amino acid vasoactive intestinal peptide (VIP) and a 27-amino acid PHI (peptide histidine isoleucine). Multiple alignment analysis showed that VIP shares 100% identity with the given birds, reptiles, and African clawed frog, and 89% identity with mammals, 96% with fishes. Real-time quantitative PCR showed that the prepro-caVIP is widely expressed in all the examined tissues, and the expression level is significantly higher in small intestine, stomach, pancreas, lung, and skeletal muscle, whereas lower in heart, liver, spleen, kidney, ovary, and oviduct. During hibernation, the expression level of caVIP was significantly decreased in small intestine ($P < 0.01$), pancreas, and skeletal muscle ($P < 0.05$), whereas significantly increased in liver, spleen, and lung ($P < 0.01$). The wide distribution of caVIP and its differential expression changes in various tissues during hibernation implicated that it might play multiple effects in Chinese alligator and participate in the physiological adaptation of various organs in a paracrine and/or neurocrine manner.

Johnston, S.D., López-Fernández, C., Arroyo, F., Fernández, J.L. and Gosálvez, J. (2017). The assessment of sperm DNA fragmentation in the saltwater crocodile (*Crocodylus porosus*). *Reproduction, Fertility and Development* 29(3): 630-636.

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

Nilsen, F.M., Dorsey, J.E., Lowers, R.H., Guillette, L.J. Jr., Long, S.E., Bowden, J.A. and Schock, T.B. (2017). Evaluating mercury concentrations and body condition in American alligators (*Alligator mississippiensis*) at Merritt Island National Wildlife Refuge (MINWR), Florida. *Sci. Total Environ.* (doi: 10.1016/j.scitotenv.2017.07.073).

Abstract: Concentrations of mercury (Hg) are not well studied in free-ranging wildlife. Atmospheric deposition patterns of Hg have been studied in detail and have been modeled for both global and specific locations and often correlate to environmental impact. However, monitoring the impact of Hg deposition in wildlife is complicated due to local environmental conditions that can affect the transformation of atmospheric Hg to the biologically available forms (eg rainfall, humidity, pH, the ability of the environment to methylate Hg), as well as affect the accessibility to organisms for sampling. In this study, Hg concentrations in blood samples from a population of American alligators (*Alligator mississippiensis*) at Merritt Island National Wildlife Refuge (MINWR), FL, USA, over

a 7-year period (2007 to 2014; $n = 174$ individuals) were examined to assess Hg variation in the population, as well as the difference in Hg concentration as a function of health status. While most of this population is healthy, 18 individuals with low body mass indices (BMI, defined in this study) were captured throughout the sampling period. These alligators exhibited significantly elevated Hg concentrations compared to their age/sex/season matched counterparts with normal BMI, suggesting that health status should be taken into account when examining Hg concentrations and effects. Alligator blood Hg concentrations were related to the interaction of age/size, sex, and season. This study illustrates the value of a routinely monitored population of large predators in a unique coastal wetland ecosystem, and illuminates the value of long-term environmental exposure assessment.

Zhai, T., Yang, H.Q., Zhang, R.C., Fang, L.M., Zhong, G.H. and Fang, S.G. (2017). Effects of population bottleneck and balancing selection on the Chinese Alligator are revealed by locus-specific characterization of MHC genes. *Sci. Rep.* 7(1): 5549 (doi: 10.1038/s41598-017-05640-2).

Abstract: Chinese alligator (*Alligator sinensis*) is an endangered freshwater crocodilian endemic to China, which experienced a severe bottleneck about 30 years ago. In this study, we developed locus-specific primers to investigate the polymorphism of 3 major histocompatibility complex (MHC) loci in 3 Chinese alligator populations, in combination with 6 neutral microsatellite markers as a contrast. We found the genetic trace for the bottleneck effect on the endangered Chinese alligator: the low allelic diversity (2 alleles at each locus), the low nucleotide substitution rate (no more than 0.009) at all sites, the deviation from Hardy-Weinberg Equilibrium/heterozygote deficiency, and the significant Tajima's D values, indicating the MHC class I and class II loci being at different stages of bottleneck. We also obtained 3 pieces of evidence for balancing selection on this severely bottlenecked reptile: an obvious excess of nonsynonymous substitutions over synonymous at the antigen-binding positions, the mean synonymous substitution rate of MHC exons significantly higher than mean nucleotide substitution rate of introns, and the differentiation coefficient F_{ST} of MHC loci significantly lower than that of microsatellite loci. Consequently, we emphasize that the Chinese alligator holds a pretty low adaptive ability and requires scientific conservation strategies to ensure the long-term population development.

Price, E.R., Sirsat, T.S., Sirsat, S.K.G., Kang, G., Keereetaweep, J., Aziz, M., Chapman, K.D. and Dzialowski, E.M. (2017). Thermal acclimation in American alligators: Effects of temperature regime on growth rate, mitochondrial function, and membrane composition. *J. Therm. Biol.* 68(Pt A): 45-54.

Abstract: We investigated the ability of juvenile American alligators (*Alligator mississippiensis*) to acclimate to temperature with respect to growth rate. We hypothesized that alligators would acclimate to cold temperature by increasing the metabolic capacity of skeletal muscles and the heart. Additionally, we hypothesized that lipid membranes in the thigh muscle and liver would respond to low temperature, either to maintain fluidity (via increased unsaturation) or to maintain enzyme reaction rates (via increased docosahexaenoic acid). Alligators were assigned to one of 3 temperature regimes beginning at 9 mo of age: constant warm (30°C), constant cold (20°C), and daily cycling for 12 h at each temperature. Growth rate over the following 7 mo was highest in the cycling group, which we suggest occurred via high digestive function or feeding activity during warm periods and energy-saving during cold periods. The warm group also grew faster than the cold group. Heart and liver masses were proportional to body mass, while kidney was proportionately larger in the cold group compared to the warm animals. Whole-animal metabolic rate was higher in the warm and cycling groups compared to the cold group - even when controlling for body mass - when assayed at 30°C, but not at 20°C. Mitochondrial oxidative phosphorylation capacity in permeabilized fibers of thigh

muscle and heart did not differ among treatments. Membrane fatty acid composition of the brain was largely unaffected by temperature treatment, but adjustments were made in the phospholipid headgroup composition that are consistent with homeoviscous adaptation. Thigh muscle cell membranes had elevated polyunsaturated fatty acids in the cold group relative to the cycling group, but this was not the case for thigh muscle mitochondrial membranes. Liver mitochondria from cold alligators had elevated docosahexaenoic acid, which might be important for maintenance of reaction rates of membrane-bound enzymes.

Magnusson, W.E. (2017). Crocodilia diet. In Encyclopedia of Animal Cognition and Behavior, ed. by J. Vonk and T. Shackelford. Springer International Publishing. (doi: 10.1007/978-3-319-47829-6_973-1).

Chen, Y., Cai, S., Qiao, X., Wu, M., Guo, Z., Wang, R., Kuang, Y.Q., Yu, H. and Wang, Y. (2017). As-CATH1~6, novel cathelicidins with potent antimicrobial and immunomodulatory properties from *Alligator sinensis*, play pivotal roles in host anti-microbial immune responses. Biochem. J. (doi: 10.1042/BCJ20170334).

Abstract: Crocodilians are regarded as possessing a powerful immune system. However, the composition and action of crocodilian immune system has remained unclear until now. Cathelicidins, the principal family of host defense peptides, play pivotal roles in vertebrate immune defense against microbial invasions. However, cathelicidins from crocodilians have not been extensively studied to date. In the present study, six novel cathelicidins (As-CATH1~6) were identified and characterized from the endangered Chinese Alligator (*Alligator sinensis*). As-CATH1~6 exhibit no sequence similarity with any of the known cathelicidins. Structure analysis indicated that As-CATH1~3 adopt a random coil secondary conformation, while As-CATH4~6 were predicted to mainly adopt an amphipathic α -helix conformation. Among them, As-CATH4~6 exhibited potent, broad-spectrum and rapid antimicrobial activity by inducing the disruption of cell membrane integrity. They also exhibited strong ability to prevent the formation of bacterial biofilms and eradicate preformed biofilms. Furthermore, As-CATH4~6 exhibited potent anti-inflammatory activity by inhibiting the LPS-induced production of nitric oxide (NO) and pro-inflammatory cytokines in mouse peritoneal macrophages. They directly neutralized the LPS toxicity and therefore inhibited the binding of LPS to TLR4 receptor and the subsequent activation of inflammatory response pathways. In a peritonitis mice model, As-CATH2~6 provided effective protection against bacterial infection through enhanced immune cell recruitment. In the host Chinese Alligator, As-CATH1~6 are mainly expressed in immune organs and epithelial tissues. Bacterial infection significantly enhances their expression, which implies an important role in host anti-infective response. Taken together, the diversity and multiple functions of As-CATH1~6 partially reveal the powerful immune system of the Chinese Alligator.

Nijman, V. and Bergin, D. (2017). Reptiles traded in markets for medicinal purposes in contemporary Morocco. Contributions to Zoology 86(1): 39-50.

Abstract: Reptiles are traded globally for medicinal purposes. Historic qualitative accounts of reptiles used as medicine in Morocco are numerous, but contemporary quantitative data are rare. In 2013-2014, we surveyed 49 wildlife markets in 20 towns throughout Morocco, plus the Spanish exclaves of Ceuta and Melilla. We recorded 1586 specimens of at least 9 species for sale in 14 of the Moroccan markets with a combined value of about US\$100,000. The most prominent markets were those in Marrakesh, Meknes, Casablanca, and Fez, with the former two cities trading equal quantities of dried and live specimens and the latter two trading mainly dried specimens. Common species were the Mediterranean chameleon (*Chamaeleo chamaeleon*) with 720 specimens (506 dried, 214 alive) and the Bell's Dabb lizard (*Uromastyx acanthinura*) with

428 specimens (247 dried, 181 alive), both traded in 10 markets, and spur-thighed tortoise (*Testudo graeca*; 57 carapaces), for sale in eight cities. Over 200 African rock python (*Python sebae*) skins were identified and may have been illicitly imported from other parts of Africa. The turnover of Mediterranean chameleon and Bell's Dabb lizard specimens after four weeks as measured by repeat surveys was 66% for both species, resulting in an estimated annual turnover of 1,520 chameleons (range 921-2303) and 775 lizards (range 364-1174). Despite legal protection and regulations locally within Morocco and internationally through CITES, reptiles are commonly and openly traded for medicinal purposes throughout Morocco. However, traders are not forthcoming in conveying the legal status of these species and restrictions on trade to potential buyers. Increased enforcement of existing wildlife protection legislation is needed to prevent this exploitation from the illegal wildlife trade that could negatively impacts imperiled species.

Lueangsakulthai, J., Jangpromma, N., Tamsiripong, T., McKendrick, J.E., Khunkitti, W., Maddocks, S.E. and Klaynongsruang, S. (2017). A novel antibacterial peptide derived from *Crocodylus siamensis* hemoglobin hydrolysate induces membrane permeabilisation causing iron dysregulation, oxidative stress and bacterial death. Journal of Applied Microbiology (doi: 10.1111/jam.13539).

Abstract: A novel antibacterial peptide from *Crocodylus siamensis* hemoglobin hydrolysate (CHHs) was characterised for antimicrobial activity. CHHs was hydrolysed for 2 h (2h-CHH), 4 h (4h-CHH), 6 h (6h-CHH) and 8 h (8h-CHH). 8h-CHH showed antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* at concentrations of 20, 20, 20 and 10 mg ml⁻¹ (w/v), respectively. Fluorescent microscopy revealed that 8h-CHH had bactericidal activity against *E. coli* and *P. aeruginosa*. β -galactosidase assay supported by RT-qPCR demonstrated that 8h-CHH resulted in differential expression of genes involved in iron homeostasis (ftnA and bfd) and oxidative stress (sodA, soxR and oxyR). Siderophore assay indicated that 8h-CHH also impaired siderophore production with diminished expression of pvdF. This pattern of gene expression suggests that 8h-CHH triggers the release of free ferric ions in the cytoplasm. However, decreased expression of genes associated with the SOS response (recA and lexA) in combination with neutral comet revealed that no DNA damage was caused by 8h-CHH. Membrane permeabilisation assay indicated that 8h-CHH caused membrane leakage thought to mediate the antibacterial and iron-stress responses observed, due to loss of regulated iron transport. The novel active peptide from 8h-CHH was determined as QAIHNEKVQAHGKKVL (QL17), with 41% hydrophobicity and +2 net charge. The QAIHNEKVQAHGKKVL fragment of *C. siamensis* hemoglobin is antibacterial via a mechanism that likely relies on iron dysregulation and oxidative stress which results in bacterial death. We have described for the first time, a novel peptide derived from *C. siamensis* hemoglobin hydrolysate, that has the potential to be developed as a novel antimicrobial peptide.

Twilprawat, P., Kim, S., Srikulnath, K. and Han, K. (2017). Structural variations generated by simian foamy virus-like (SFV) in *Crocodylus siamensis*. Genes and Genomics (doi:10.1007/s13258-017-0581-0).

Abstract: Endogenous retrovirus (ERV) integrates into the germline of its host and could remain in the genome as a molecular fossil. ERV is one of sources that cause INDEL and recombination events in the vertebrate genomes, leading to various genomic and genetic changes in their hosts. There have been many studies conducted on ERVs in the vertebrate genomes to elucidate their evolutionary history. However, ERVs have not been studied well in *Crocodylus siamensis*. Here, we report structural variations among SFV1 elements (simian foamy virus-like), ERVs in *C. siamensis*. We initially identified 26 SFV1 candidates in the genome and experimentally verified 9 SFV1_1 and 5 SFV1_10 elements using PCR display. Their structural analyses showed that most of them are

solitary-LTRs but two SFV1_1 elements are full-length. Through further analyses, we found that the two full-length elements retain intact ORFs. We examined transcription factor binding sites within their LTR sequences to predict promoter/enhancer activities. In sum, we identified 14 crocodile-specific SFV1 elements and the results of their structural analyses suggest that they could contribute to genomic or phenotypic variations in *C. siamensis* population.

Tipton, J.J., Guillette Jr., L.J., Lovelace, S., Parrott, B.B., Rainwater, T.R. and Reiner, J.L. (2017). Analysis of PFAAs in American alligators part 1: Concentrations in alligators harvested for consumption during South Carolina public hunts. *Journal of Environmental Sciences* (<https://doi.org/10.1016/j.jes.2017.05.045>).

Abstract: Environmental contamination resulting from the production or release of harmful chemicals can lead to negative consequences for wildlife and human health. Perfluorinated alkyl acids (PFAAs) were historically produced as protective coatings for many household items and currently persist in the environment, wildlife, and humans. PFAAs have been linked to immune suppression, endocrine disruption, and developmental toxicity in wildlife and laboratory studies. This study examines the American alligator, *Alligator mississippiensis*, as an important indicator of ecosystem contamination and a potential pathway for PFAA exposure in humans. Alligator meat harvested in the 2015 South Carolina (SC) public hunt season and prepared for human consumption was collected and analyzed for PFAAs to determine meat concentrations and relationships with animal body size (total length), sex, and location of harvest. Of the 15 PFAAs analyzed, perfluorooctane sulfonate (PFOS) was found in all alligator meat samples and at the highest concentrations (median 6.73 ng/g). No relationship was found between PFAA concentrations and total length or sex. Concentrations (of one or all compounds varied significantly across sampling locations, with alligators harvested in the Middle Coastal hunt unit having the highest PFOS concentrations (median 16.0 ng/g; $p = 0.0001$). Alligators harvested specifically from Berkeley County, SC (located in the Middle Coastal hunt unit) had the highest PFOS concentrations and the greatest number of PFAAs detected ($p < 0.0001$). The site-specific nature of PFAA concentrations in alligator meat observed in this study suggests a source of PFAA contamination in Berkeley County, SC.

Barão-Nóbrega, J.A.L., Marioni, B., Botero-Arias, R., Nogueira, A.J.A., Lima, E.S., Magnusson, W.E., Da Silveira, R., and Marcon, J.L. (2017). The metabolic cost of nesting: body condition and blood parameters of *Caiman crocodilus* and *Melanosuchus niger* in Central Amazonia. *Journal of Comparative Physiology B* (doi: 10.1007/s00360-017-1103-8).

Abstract: Although nesting ecology is well studied in several crocodilian species, it is not known how nest attendance influences physiology and body condition of nesting females. In this study, we describe body condition and serum biochemical values of nesting female, non-nesting female and male Spectacled caiman (*Caiman crocodilus*) and Black caiman (*Melanosuchus niger*) in two areas of Central Amazonia. We also evaluated the effect of nest age and nest distance to water on body condition and blood parameters of nesting females. Body condition and plasmatic concentrations of glucose, triglycerides, lactate and uric acid of nesting females were significantly different from those of non-nesting females and males in *C. crocodilus*, but not in *M. niger*. Our study also demonstrated that nest age and distance to water had a negative effect on female body condition in *C. crocodilus*, but not in *M. niger*. Female *C. crocodilus* attending older nests or nests built further away from permanent water bodies tended to have lower body condition. Our results demonstrate that the nesting strategy of *C. crocodilus* has a metabolic cost associated with nest attendance for nesting females, which appear to depend on accumulated energetic reserves during nest attendance. In contrast, nest attendance had little effect on the physiology of female *M. niger*.

Zhao, J.H., Tu, G.J., Wu, X.B. and Li, C.P. (2017). Characterization of the complete mitochondrial genome of *Ortleppascaris sinensis* (Nematoda: Heterocheilidae) and comparative mitogenomic analysis of eighteen Ascaridida nematodes. *J. Helminthol.* (doi: 10.1017/S0022149X17000542).

Abstract: *Ortleppascaris sinensis* (Nematoda: Ascaridida) is a dominant intestinal nematode of the captive Chinese alligator. However, the epidemiology, molecular ecology and population genetics of this parasite remain largely unexplored. In this study, the complete mitochondrial (mt) genome sequence of *O. sinensis* was first determined using a polymerase chain reaction (PCR)-based primer-walking strategy, and this is also the first sequencing of the complete mitochondrial genome of a member of the genus *Ortleppascaris*. The circular mitochondrial genome (13,828 bp) of *O. sinensis* contained 12 protein-coding, 22 transfer RNA and 2 ribosomal RNA genes, but lacked the ATP synthetase subunit 8 gene. Finally, phylogenetic analysis of mtDNAs indicated that the genus *Ortleppascaris* should be attributed to the family Heterocheilidae. It is necessary to sequence more mtDNAs of *Ortleppascaris* nematodes in the future to test and confirm our conclusion. The complete mitochondrial genome sequence of *O. sinensis* reported here should contribute to molecular diagnosis, epidemiological investigations and ecological studies of *O. sinensis* and other related Ascaridida nematodes.

Chaipayang, S., Songsirithigul, C., Chen, C.-J., Palacios, P.M., Pierce, B.S., Jangpromma, N. and Klaynongsruang, S. (2017). Purification, characterization, cloning and structural analysis of *Crocodylus siamensis* ovotransferrin for insight into functions of iron binding and autocleavage. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology* (<https://doi.org/10.1016/j.cbpb.2017.06.006>).

Abstract: Ovotransferrin, the major protein constituent of egg white, is of great interest due to its pivotal role in biological iron transport and storage processes and its spontaneous autocleavage into peptidic fragments with alternative biological properties, such as antibacterial and antioxidant activity. However, despite being well-investigated in avian, a detailed elucidation of the structure-function relationship of ovotransferrins in the closely related order of Crocodilia has not been reported to date. In this study, electron paramagnetic resonance (EPR) confirmed the presence of two spectroscopically distinct ferric iron binding sites in *Crocodylus siamensis* OTf (cOTf), but implied a five-fold lower quantity of bound iron than in hen OTf (hOTf). In addition, quantitative estimation of free sulfhydryl groups revealed slight differences to hOTf. To gain a better structural understanding of cOTf, we found a cOTf gene consisting of an open reading frame of 2040 bp and encoding a protein of 679 amino acids. In-silico prediction of the three-dimensional structure of cOTf and comparison with hOTf revealed four evolutionarily conserved iron-binding sites in both N- and C-lobes, as well the presence of only 13 of the 15 disulfide bonds in hOTf. This evolutionary loss of disulfide linkages in conjunction with the lack of hydrogen bonding from a dilysine trigger in the C-lobe are presumed to affect the iron binding and autocleavage character of cOTf. As a result, cOTf may be capable of exerting a more diverse array of functions compared to its avian counterparts; for instance, ion buffering, antioxidant and antimicrobial activities.

Briggs-Gonzalez, V., Bonenfant, C., Basille, M., Cherkiss, M., Beauchamp, J. and Mazzotti, F. (2017). Life histories and conservation of long-lived reptiles, an illustration with the American Crocodile (*Crocodylus acutus*). *J. Anim. Ecol.* (doi: 10.1111/1365-2656.12723).

Abstract: Successful species conservation is dependent on adequate estimates of population dynamics, but age-specific demographics are generally lacking for many long-lived iteroparous species such as large reptiles. Accurate demographic information allows estimation of population growth rate, as well as projection of future

population sizes and quantitative analyses of fitness trade-offs involved in evolution of life-history strategies. Here, a long-term capture-recapture study was conducted from 1978-2014 on the American crocodile (*Crocodylus acutus*) in southern Florida. Over the study period, 7427 hatchlings were marked and 380 individuals were recaptured for as many as 25 years. We estimated survival to be strongly age-dependent with hatchlings having the lowest survival rates (16%) but increasing to nearly 90% at adulthood based on mark-recapture models. More than 5% of the female population were predicted to be reproductive by age 8 years; the age-specific proportion of reproductive females steadily increased until age 18 when more than 95% of females were predicted to be reproductive. Population growth rate, estimated from a Leslie-Lefkovich stage-class model, showed a positive annual growth rate of 4% over the study period. Using a prospective sensitivity analysis, we revealed that the adult stage, as expected was the most critical stage for population growth rate; however, the survival of younger crocodiles before they became reproductive, also had a surprisingly high elasticity. We found that variation in age-specific fecundity has very limited impact on population growth rate in American crocodiles. We used a comparative approach to show that the original life history strategy of American crocodiles is actually shared by other large, long-lived reptiles: while adult survival rates always have a large impact on population growth, this decreases with declining growth rates, in favor of a higher elasticity of the juvenile stage. Crocodiles, as a long-lived and highly fecund species deviate from the usual association of life-histories of “slow” species. Current management practices are focused on nests and hatchling survival; however, protection efforts that extend to juvenile crocodiles would be most effective for conservation of the species, especially in an ever-developing landscape.

Chabrolles, L., Coureaud, G., Boyer, N., Mathevon, N. and Beauchaud, M. (2017). Cross-sensory modulation in a future top predator, the young Nile crocodile. *Royal Society Open Science* 4: 170386.

Abstract: Animals routinely receive information through different sensory channels, and inputs from a modality may modulate the perception and behavioural reaction to others. In spite of their potential adaptive value, the behavioural correlates of this cross-sensory modulation have been poorly investigated. Due to their predator life, crocodilians deal with decisional conflicts emerging from concurrent stimuli. By testing young *Crocodylus niloticus* with sounds in the absence or presence of chemical stimuli, we show that (i) the prandial (feeding) state modulates the responsiveness of the animal to a congruent, ie food-related olfactory stimulus, (ii) the prandial state alters the responsiveness to an incongruent (independent of food) sound, (iii) fasted, but not sated, crocodiles display selective attention to socially relevant sounds over noise in presence of food odour. Cross-sensory modulation thus appears functional in young Nile crocodiles. It may contribute to decision making in the wild, when juveniles use it to interact acoustically when foraging.

Yi, H., Tennant, J.P., Young, M.T., Challands, T.J., Foffa, D., Hudson, J.D., Ross, D.A. and Brusatte, S.L. (2017). An unusual small-bodied crocodyliform from the Middle Jurassic of Scotland, UK, and potential evidence for an early diversification of advanced neosuchians. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 2017: 1-12.

Abstract: The Middle Jurassic is a poorly sampled time interval for non-pelagic neosuchian crocodyliforms, which obscures our understanding of the origin and early evolution of major clades. Here we report a lower jaw from the Middle Jurassic (Bathonian) Duntulm Formation of the Isle of Skye, Scotland, UK, which consists of an isolated and incomplete left dentary and part of the splenial. Morphologically, the Skye specimen closely resembles the Cretaceous neosuchians *Pachycheilosuchus* and *Pietraroiasuchus*, in having a proportionally short mandibular symphysis, shallow

dentary alveoli and inferred weakly heterodont dentition. It differs from other crocodyliforms in that the Meckelian canal is dorsoventrally expanded posterior to the mandibular symphysis and drastically constricted at the 7th alveolus. The new specimen, together with the presence of *Theriosuchus* sp. from the Valtos Formation and indeterminate neosuchians from the Kilmaluag Formation, indicates the presence of a previously unrecognised, diverse crocodyliform fauna in the Middle Jurassic of Skye, and Europe more generally. Small-bodied neosuchians were present, and ecologically and taxonomically diverse, in nearshore environments in the Middle Jurassic of the UK.

Stein, M.D., Yates, A., Hand, S.J. and Archer, M. (2017). Variation in the pelvic and pectoral girdles of Australian Oligo-Miocene mekosuchine crocodiles with implications for locomotion and habitus. *PeerJ* 5:e3501.

Abstract: Australian Oligo-Miocene mekosuchines (Crocodylia; Crocodyloidea) display wide diversity in cranial shape and inferred hunting strategies. Terrestrial habitus has been inferred for these distinctive predators. A direct morphological signal for locomotion can be expected in the postcrania, particularly the pelvic and pectoral girdles. Here we describe fossil materials of the girdles, which chart their morphological variation in the subfamily from Eocene through to Middle Miocene. Over this period, both girdles undergo significant morphological changes. Notably, an enclosed, ventrally orientated acetabulum in the ilium is developed in one lineage. This recapitulates the erect parasagittal configuration of the pelvic limb seen in many Mesozoic crocodylomorph lineages, suggesting consistent use of erect high-walking in these mekosuchines. Other pelves from the same Oligo-Miocene deposits display morphology closer to modern crocodilians, suggesting a partitioning of locomotory strategy among sympatric mekosuchines. Plesiomorphic and derived pelvic girdles are distinguishable by parsimony analysis, and the earliest examples of the mekosuchine pelvis more closely resemble gavialids and alligatorids while latter forms converge on crown group crocodylids in the morphology of the iliac crest. This suggests that a reevaluation of the base relationship of Mekosuchinae within Eusuchia is necessary.

Simionato Tavares, S.A., Ricardi Branco, F., de Souza Carvalho, I. and Maldanis, L. (2017). The morphofunctional design of *Montealtosuchus arrudacamposi* (Crocodyliformes, Upper Cretaceous) of the Bauru Basin, Brazil. *Cretaceous Research* (<https://doi.org/10.1016/j.cretres.2017.07.003>).

Abstract: *Montealtosuchus arrudacamposi*, a Peirosauridae from the Upper Cretaceous of the Bauru Basin, was a Crocodyliformes of terrestrial habits. The fossils analyzed in this study belong to the pectoral girdle (scapula and coracoid) and anterior appendicular skeleton (humerus, radius, ulna, carpals, radiale, ulnale, metacarpals and phalanges). In this study we infer the locomotion habits of *M. arrudacamposi*. A morphometric, morphofunctional and 3D reconstruction of the elements of the pectoral girdle and the anterior limbs of *M. arrudacamposi* were performed. For a better understanding of the most plausible pectoral girdle and anterior limb posture, the studied bones were virtually disarticulated and articulated on 3D reconstruction. The herein results obtained indicate the structures present a relatively thin and elongated aspect, thus allowing an interpretation that *M. arrudacamposi* possessed more slender anterior limbs than living crocodyliforms. This condition allowed for an adducted stance and cursorial habits that would enable movement through terrestrial environments for prey searching.

Junker, K. and Mutafovich, Y. (2017). *Micropleura huchzermeyeri* n. sp. (Camallanida: Dracunculoidea: Micropleuridae) from the Nile crocodile, *Crocodylus niloticus* Laurenti (Reptilia: Crocodylidae), in South Africa. *Systematic Parasitology* (doi:10.1007/s11230-017-9742-4).

Abstract: *Micropleura huchzermeyeri* n. sp. (Camallanida: Dracunculoidea: Micropleuridae) is described from the peritoneal cavity of *Crocodylus niloticus* Laurenti (Reptilia: Crocodylidae), based on a detailed study of its morphology using light and scanning electron microscopy. The new species is compared with its congeners, *M. australiensis* Moravec, Kay & Hobbs, 2004, *M. vazi* Travassos, 1933 and *M. vivipara* von Linstow, 1906 from crocodilians, and with *M. indica* Khera, 1951 from chelonian hosts. It can be distinguished from these by the length of its spicules, which are longer than in all described species and a combination of characters, including the presence of prominent lateral caudal papillae on the level of the cloaca in males, the presence of conspicuous phasmids on the female tail, the pre-equatorial position of the vulva and the length of the first-stage larvae. *Micropleura huchzermeyeri* n. sp. is further characterised by having 14 cephalic papillae in both sexes and ten pairs of caudal papillae in males. This is the first report of a representative of the genus *Micropleura* von Linstow, 1906 from a crocodilian in the Afrotropical region. *Micropleura helicospicula* Dey Sarkar, 2003 is considered a species *incertae sedis*.

Gelabert, C., Rositano, F. and González, O. (2017). Sustainable use of caiman in Argentina: An analysis from the perspective of the stakeholders involved. *Biological Conservation* 212 (Part A): 357-365.

Abstract: Commercial use of wildlife is considered a potential tool of conservation and sustainable development, under the ideological assumption that the economic valuation of them generates incentives for conservation, as well as the ecosystems they inhabit, while benefiting local communities. However, many authors question the scope of these initiatives. The reptiles represent 61% of the value of this trade. Two species of *Caiman* genus inhabit Argentina. In 1997, a ranching farm was developed in Santa Fe province; between 1997 and 2004, more ranching farms were developed in other four Argentinean provinces. This paper aims to develop a conceptual model of the production system and its influence on sustainability trajectory in commercial use of caiman in Argentina based on the stakeholders' perception. The information obtained from interviews was organized into two results: 1) a conceptual model representing the caiman production system, and 2) a stakeholder network. This paper provided insights about the caiman production system and its articulation with the stakeholders involved. Throughout the qualitative analyses here implemented, we have obtained a diagnostic tool which could be converted into a planning tool incorporating quantitative information.

Hale, M.D., Galligan, T.M., Rainwater, T.R., Moore, B.C., Wilkinson, P.M., Guillette, L.J. and Parrott, B.B. (2017). AHR and CYP1A expression link historical contamination events to modern day developmental effects in the American alligator. *Environ. Pollut.* 230: 1050-1061.

Abstract: The aryl hydrocarbon receptor (AHR) is a ligand-activated transcription factor that initiates a transcriptional pathway responsible for the expression of CYP1A subfamily members, key to the metabolism of xenobiotic compounds. Toxic planar halogenated aromatic hydrocarbons, including dioxin and PCBs, are capable of activating the AHR, and while dioxin and PCB inputs into the environment have been dramatically curbed following strict regulatory efforts in the United States, they persist in the environment and exposures remain relevant today. Little is known regarding the effects that long-term chronic exposures to dioxin or dioxin-like compounds might have on the development and subsequent health of offspring from exposed individuals, nor is much known regarding AHR expression in reptilians. Here, we characterize AHR and CYP1A gene expression in embryonic and juvenile specimen of a long-lived, apex predator, the American alligator (*Alligator mississippiensis*), and investigate variation in gene expression profiles in offspring collected from sites conveying differential exposures to environmental contaminants. Both age- and tissue-dependent patterning of AHR isoform expression are detected.

We characterize two downstream transcriptional targets of the AHR, CYP1A1 and CYP1A2, and describe conserved elements of their genomic architecture. When comparisons across different sites are made, hepatic expression of CYP1A2, a direct target of the AHR, appears elevated in embryos from a site associated with a dioxin point source and previously characterized PCB contamination. Elevated CYP1A2 expression is not persistent, as site-specific variation was absent in juveniles originating from field-collected eggs but reared under lab conditions. Our results illustrate the patterning of AHR gene expression in a long-lived environmental model species, and indicate a potential contemporary influence of historical contamination. This research presents a novel opportunity to link contamination events to critical genetic pathways during embryonic development, and carries significant potential to inform our understanding of potential health effects in wildlife and humans.

Lessner, E.J. and Stocker, M.R. (2017). Archosauriform endocranial morphology and osteological evidence for semiaquatic sensory adaptations in phytosaurs. *J. Anat.* (doi: 10.1111/joa.12668).

Abstract: The examination of endocranial data of archosauriforms has led to advances on the evolution of body size, nerve pathways, and sensory abilities. However, much of that research has focused on bird-line archosaurs, resulting in a skewed view of Archosauria. Phytosauria, a hypothesized sister taxon to or early-branching member of Archosauria, provides a potential outgroup condition. Most previous phytosaur endocranial studies were executed without the use of modern technology and focused on derived members of Phytosauria. We present a comparative CT examination of the internal cranial anatomy of *Wannia scurriensis*, the most basal known parasuchid phytosaur. *Wannia scurriensis* shows some overall similarity with extant crocodylians and derived phytosaurs in general endocranial shape, a large hypophyseal fossa, and trigeminal (CN V) innervation, but as a whole, the endocranial has noticeable differences to crocodylians and other phytosaurs. The pineal region is expanded dorsally as in other phytosaurs but also laterally (previously unrecognized). CN V exits the pons in a more dorsal position than in *Parasuchus hislopi*, *Machaeropsopos mccauleyi*, or *Smilosuchus gregorii*. *Wannia scurriensis* also exhibits a larger hypophyseal fossa relative to brain size than observed in *P. hislopi* or *S. gregorii*, which may indicate more rapid growth. The well-preserved semicircular canals have lateral canals that are angled more anteroventrally than in derived phytosaurs. Extensive facial innervation from the large CN V indicates increased rostrum sensitivity and mechanoreceptive abilities as in *Alligator mississippiensis*. These endocranial similarities among phytosaurs and with *Alligator* indicate conserved ecological and functional results of an aquatic lifestyle, and highlight a need for further exploration of endocranial anatomy among Archosauriformes.

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), More, S., Bøtner, A., Butterworth, A., Calistri, P., Depner, K., Edwards, S., Garin-Bastuji, B., Good, M., Gortazar Schmidt, C., Michel, V., Miranda, M.A., Nielsen, S.S., Raj, M., Sihvonen, L., Spooler, H., Stegeman, J.A., Thulke, H.-H., Velarde, A., Willeberg, P., Winckler, C., Baldinelli, F., Broglia, A., Dhollander, S., Beltran-Beck, B., Kohnle, L., Morgado, J. and Bicout, D. (2017). Scientific opinion on the assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): West Nile fever. *EFSA Journal* 15(8): 4955. (<https://doi.org/10.2903/j.efsa.2017.4955>).

Abstract: West Nile fever (WNF) has been assessed according to the criteria of the Animal Health Law (AHL), in particular criteria of Article 7 on disease profile and impacts, Article 5 on the eligibility of WNF to be listed, Article 9 for the categorisation of WNF according to disease prevention and control rules as in Annex IV and Article 8 on the list of animal species related to WNF. The assessment has been performed following a methodology composed of information collection and compilation, expert judgement on each criterion at individual and, if no consensus was reached before, also at collective

level. The output is composed of the categorical answer, and for the questions where no consensus was reached, the different supporting views are reported. Details on the methodology used for this assessment are explained in a separate opinion. According to the assessment performed, WNF can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL. The disease would comply with the criteria as in Sections 2 and 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in points (b) and (e) of Article 9(1). The animal species to be listed for WNF according to Article 8(3) criteria are several orders of birds and mammals as susceptible species and several families of birds as reservoir. Different mosquito species can serve as vectors.

Widelitz, R.B., Abdelhamid, A., Khan, M.K., Elkarargy, A., Chuong, C.-M. and Wu, P. (2017). MicroCT imaging on living alligator teeth reveals natural tooth cycling. Pp. 355-362 in *Avian and Reptilian Developmental Biology. Methods in Molecular Biology*, Vol. 1650. Humana Press: New York.

Abstract: To study tooth cycling in polyphyodont animals, we chose to work on alligators. Alligators have teeth in three phases of development at each tooth location. This assembly of three teeth is called a tooth family unit. As part of the study, in order to study tooth cycling in alligators, we wanted to know the configuration of the tooth family unit in every tooth position. From the surface of the mouth, this is difficult to assess. Therefore, we decided to use MicroCT which can image X-ray dense materials providing a three-dimensional view. MicroCT provided us with valuable information for this study. The method described below can be applied to study tooth cycling in other vertebrate species.

Nickum, M.J., Masser, M., Reigh, R. and Nickum, J.G. (2017). Alligator (*Alligator mississippiensis*) aquaculture in the United States. *Reviews in Fisheries Science and Aquaculture* (<http://dx.doi.org/10.1080/23308249.2017.1355350>).

Abstract: Commercial production of American alligator (*Alligator mississippiensis*) under intensive aquaculture conditions began in the 1980s. During the last 30 years, alligator farming has become an aquacultural industry worth millions of dollars in the southern United States. In 2014, farmers in Louisiana, the nation's largest producer of captive-reared alligators, sold more than 383,000 skins valued at more than \$77 million. Most alligator farming operations utilize wild-sourced eggs, which are collected from wetland habitats under the authority of permits issued by State agencies. Typically, these permits include a requirement to return a portion of farm-reared animals to the same area where eggs were collected to maintain wild populations. Intensive rearing of alligators requires an abundance of warm water and good quality food. Extruded feeds formulated specifically for alligator are the industry standard in modern production systems. Disease can be an occasional problem in alligator production operations but risks can be minimized with provision of clean water, high-quality feed, and good hygienic conditions in grow-out facilities. Belly skins are the primary product of alligator aquaculture, but alligator meat is also sold in niche markets. Although products made from alligator skins have strong consumer appeal, the relatively high cost of products made with alligator leather limits sales to more affluent consumers. Growth of alligator farming, using current production methods, will be limited by the natural productivity of the wild resource upon which the industry depends and demand for products utilizing alligator leather. From 2004 to 2013, global demand for skins of all species of crocodilians averaged 1.4 million skins annually, of which 24.3% were American alligator.

Xu, C., Grizante, M.B. and Kusumi, K. (2017). Somitogenesis and axial development in reptiles. Pp. 335-353 in *Avian and Reptilian Developmental Biology. Methods in Molecular Biology*, Vol. 1650. Humana Press: New York.

Abstract: Among amniote vertebrates, reptiles display the greatest variation in axial skeleton morphology. Only recently have they been used in gene expression studies of somitogenesis, challenging previous assumptions about the segmentation clock and axial patterning. An increasing number of reptile genomes and transcriptomes are becoming available as next-generation sequencing becomes more affordable. Information regarding gene sequence and structure can be used to design and synthesize labeled riboprobes by in vitro transcription for gene expression analysis by in situ hybridization, thus, enabling the characterization of spatial and temporal expression patterns of genes involved in somitogenesis, a topic of great interest within evolutionary developmental studies of vertebrates.

Hernández-Mena, D.I., García-Varela, M. and Pérez-Ponce de León, G. (2017). Filling the gaps in the classification of the Digenea Carus, 1863: systematic position of the Proterodiplostomidae Dubois, 1936 within the superfamily Diplostomoidea Poirier, 1886, inferred from nuclear and mitochondrial DNA sequences. *Systematic Parasitology* (doi:10.1007/s11230-017-9745-1).

Abstract: The Diplostomida Olson, Cribb, Tkach, Bray & Littlewood, 2003 is the less diverse order of the two orders within the subclass Digenea Carus, 1863 and is currently classified into three superfamilies, ie Brachylaimoidea Joyeux & Foley, 1930, Diplostomoidea Poirier, 1886, and Schistosomatoidea Stiles & Hassall, 1898. Although the suprageneric-level relationships have been elucidated with the use of molecular markers, the lack of representation of some groups obscure the phylogenetic relationships among families, rendering the classification unstable. Here, we tested the phylogenetic position of the family Proterodiplostomidae Dubois, 1936 based on partial 28S rDNA and complete 18S rDNA sequences for *Crocodylicola pseudostoma* (Willemoes-Suhm, 1870), a crocodile parasite that has been found as a progenetic metacercaria parasitising the pale catfish *Rhamdia guatemalensis* (Günther) in Mexico and in other siluriforms in the Neotropics. We augmented the representation of the species, genera and families within the Diplostomida, including mostly representatives of the superfamily Diplostomoidea, and assembled a dataset that contains 49 species for the 28S rRNA gene, and 45 species for the 18S rRNA gene. Additionally, we explored the phylogenetic signal of the mitochondrial gene *cox1* in reconstructing the phylogenetic relationships of selected members of the superfamily. Our analyses showed that the family Proterodiplostomidae is the sister taxon to the paraphyletic Diplostomidae Poirier, 1886 and Strigeidae Railliet, 1919, with Cyathocotylidae Mühling, 1898 + Brauninidae Wolf, 1903 as their sister group. Analysis of concatenated 18S + 28S sequences revealed the Liolopidae Odhner, 1912 as the basal group of the superfamily Diplostomoidea, although analyses of independent datasets showed that the position of this family remains uncertain. Analysis based on *cox1* unequivocally resolved the Proterodiplostomidae as the sister taxon to the Diplostomidae and Strigeidae, although the Cyathocotylidae was nested in a different clade, along with brachylaimoids and schistosomatoids.

Wood, J.P., Patton, T.M. and Page, R.B. (2017). Movement and overwinter survival of released captive-raised juvenile American alligators (*Alligator mississippiensis*) in Southeastern Oklahoma, USA. *Herpetological Review* 48(2): 293-299.

Dubansky, B.H. and Dubansky, B.D. (2017). Natural development of dermal ectopic bone in the American alligator (*Alligator mississippiensis*) resembles heterotopic ossification disorders in humans. *The Anatomical Record* (doi: 10.1002/ar.23682).

Abstract: Heterotopic ossification (HO) occurs when soft tissues are inappropriately converted to bony tissue. Several human diseases result in HO with few reliable treatment options. Animal models that naturally produce dermal ectopic bone (ie osteoderms), such as crocodilians, have never been utilized as models for studying these

disorders in humans. Here, a histological evaluation and staging criteria for osteoderm development is described for the first time in the American alligator (*Alligator mississippiensis*). Differential staining and immunohistochemistry of alligator scales depict a progressive change during development, where woven bone forms from the differentiated dermis. Data presented here indicate that bone formation proceeds via intramembranous ossification, which is initiated in part by endothelial cell precursors that undergo endothelial-to-mesenchymal transition and eventually acquire an osteoblast phenotype. As such, the development of osteoderms in the American alligator bears morphological and mechanistic similarities to HO in humans, presenting a potential model for future study of soft tissue mineralization pathologies and providing insight into the morphological and molecular development of osteoderms in other vertebrate lineages.

Keefner, A.E. (2017). How Prejudice Affects the Study of Animal Minds. PhD thesis, University of Waterloo, Ontario, Canada.

Abstract: Humans share the planet with many wonderfully diverse animal species and human-animal interactions are part of our daily lives. An important part of understanding how humans do and should interact with other animals is understanding how humans think about other animals. In this thesis, I argue that how humans think about the minds of other animals is marked by prejudice and that this prejudice fosters epistemological, metaphysical, and ethical problems related to study of, the conception of, and the conclusions we draw about animal minds. I begin by examining conceptions and representations of animals in popular culture and arguing that they exhibit and foster a problematic prejudice, what I call “animal prejudice.” I then examine how this prejudice affects the general study of animal minds and argue that it leads to epistemological problems that interfere with the aims of science. After reviewing the effects of animal prejudice on the study of animal minds generally, I more closely examine the effects of animal prejudice on the scientific study of animal problem solving, learning, tool use, language, emotion, and empathy. In addition to identifying areas where animal prejudice is negatively affecting the study of animal minds, I also offer suggestions for avoiding and mitigating these effects. To conclude, I review the ethical implications of animal prejudice and its effects on the study of animal minds. Together, these chapters offer an important philosophical contribution to the understanding of animal minds and provide a basis for further discussion on how humans should interact with other animals.

Griffin, C.T., Stefanic, C.M., Parker, W.G., Hungerbühler, A. and Stocker, M.R. (2017). Sacral anatomy of the phytosaur *Smilosuchus adamanensis*, with implications for pelvic girdle evolution among Archosauriformes. *Journal of Anatomy* (doi: 10.1111/joa.12681).

Abstract: The sacrum - consisting of those vertebrae that articulate with the ilia - is the exclusive skeletal connection between the hindlimbs and axial skeleton in tetrapods. Therefore, the morphology of this portion of the vertebral column plays a major role in the evolution of terrestrial locomotion. Whereas most extant reptiles only possess the two plesiomorphic sacral vertebrae, additional vertebrae have been incorporated into the sacrum multiple times independently among early-diverging archosaurian (crocodylians + birds) clades. Phytosauria was a diverse, abundant, and cosmopolitan clade of archosauriforms throughout the Late Triassic, but postcranial material of this clade are rarely described and few species-level taxonomic placements of phytosaurian postcranial material are available, potentially hampering knowledge of morphological disparity in the postcranial skeleton among phytosaurs. Here, we describe the sacrum of *Smilosuchus adamanensis*, a phytosaur recovered from the Upper Triassic Chinle Formation of Arizona. This sacrum consists of the two primordial sacral vertebrae, but has a vertebra incorporated from the trunk into the sacrum (= a dorsosacral) and is therefore the first Late Triassic phytosaur and one of the first non-archosaurian archosauriforms to be described with more than two sacral vertebrae. Our interpretation of this element as a dorsosacral

is justified by the lateral extent of the dorsosacral ribs, clear surfaces of articulation between the distal ends of the dorsosacral ribs and the first primordial sacral ribs, and the scar on the medial surface of each ilium for articulation with each dorsosacral rib. Additionally, we provide the first detailed description of the vertebral junction formed by two anteriorly projecting flanges on the first primordial sacral ribs and their corresponding facets on the centrum of the dorsosacral. Computed tomographic (CT) imaging reveals that the two primordial sacral ribs are not co-ossified and that the dorsosacral morphology of this specimen is not the result of obvious pathology. We place this incorporation of a trunk vertebra into the phytosaurian sacrum in a broader evolutionary context, with this shift in vertebral identity occurring at least seven times independently among Triassic archosauriforms, including at least three times in early crocodylian-line archosaurs and at least four times among bird-line archosaurs. Additionally, anteriorly projecting flanges of sacral ribs which articulate with the anterior-adjacent centrum have evolved several times in archosauriforms, and we interpret ‘shared’ sacral ribs (= a sacral rib that articulates with two adjacent sacral centra more or less equally) present in some archosaurian clades as a more extreme example of this morphology. In extant taxa the highly conserved Hox gene family plays a central role in the patterning of the axial skeleton, especially vertebral identity; therefore, the independent incorporation of a trunk vertebra into the sacrum across multiple archosauriform lineages may suggest a homologous underlying developmental mechanism for this evolutionary trend.

Gomez-González, J.J., Narvaez-Barandica, J.C., Baez, L. and Patino-Florez, E. (2017). Nesting ecology of *Crocodylus acutus* (Reptilia: Crocodylidae) in Bahía Portete, La Guajira, Colombia. *Revista de Biología Tropical* 65: 211-228.

Abstract: *C. acutus* is cataloged in critical danger in Colombia. We studied its population at Bahía Portete, in order to survey the nesting activities and to obtain valuable information for a conservation management program. This study was undertaken with the participation of the Wayui community using the Agreement Conservation Model, and took place during July 2007, August 2008, June and August 2009, and March to August 2010 and 2011. Sampling surveys were made by the use of transects along the coast, in order to find nests. For each nesting area found, we recorded the nests biometric, eggs and hatchlings, fertility of the eggs and reproductive events. We explored a total of 55.12 km, and determined four nesting areas. Colonial nesting and the environmental variables were factors that affected the hatchling success. From the total nests found, 37% were oriented towards North, and 48% were built next to *Stenocereus griseus*. Juyui Island substrate was mostly constituted by sand (71.9%, 71.44%). The average number of eggs by nest was 28.42 ± 6.63 , the largest egg diameter was 71.84 ± 3.54 mm, average egg weight was 81.54 ± 9.99 g, and hatchlings presented an average length of 25.47 ± 1.16 cm. For this specific site in Colombia, the reproductive period begins in March and ends in August. The few areas of nesting and the 95% fertility suggest the performance of a conservation management program for this species at Bahía Portete.

Suryawanshi, S. and Singh, R.K. (2017). Reproductive behaviour of adult female *Crocodylus palustris* in Kotmi Sonar District Janjgir, Champa (C.G.) in India. *Indian J. Applied & Pure Bio.* 32(1): 13-18.

Abstract: Crocodile has been categorized as a vulnerable species in the IUCN Red List and is placed under schedule of the wild life protection Act 1972 To Protect Crocodile a Crocodile conservation park has been established by the Govt. of (C.G.) in Mundapond of Kotmi Sonar Distt.- Janjgir-Champa (C.G.) India. The Environmental condition of Mundapond provide an optimal condition for reproductive behavior of *Crocodylus palustris*. The population of *C. palustris* is gradually increasing by well reproductive behaviour.

Elsey, R.M., LeJeune, D., Landry, B., Reed, K., Miller, M. and Kaller, M.D. (2017). Prevalence and details of polydactyly in the

American alligator, *Alligator mississippiensis*, in Louisiana, USA. *Herpetological Conservation and Biology* 12(2): 342-349.

Abstract: Polydactylism has been described in the American alligator (*Alligator mississippiensis*) and other crocodilians, but to our knowledge the prevalence of this limb abnormality has not been examined in detail. As part of a head start program in which juvenile alligators are released back to the wild after being hatched from eggs collected in the wild, in 2016 we examined 58,106 alligators for this condition. Polydactylism occurred in 106 alligators (0.18%). Front limbs and limbs on the right side were more commonly affected than rear limbs or those on the left side (n= 77 right front and n= 59 left front; n= 34 right rear and n= 20 left rear). Of the 106 alligators with polydactylism, extra toes were present on one limb in 46 cases (43.40%), on two limbs in 42 instances (39.62%), on three limbs in 12 alligators (11.32%) and 6 alligators had extra toes on all four limbs (5.66%). Analyses of patterns of polydactylism could not support hypotheses that polydactylism was more common on any combination of position (front, back, left, right) based on number of limbs affected. Alligators typically have 18 toes; the mean number of toes present in this series of polydactylism was $22.5 \pm$ (SD) 2.8 toes (range 19-32). One alligator had 8 toes on each limb, for a total of 32 toes present (14 more than normal). Several other cases of polydactylism were noted in review of anecdotal observations recorded from farm releases made in prior years, from hatchlings obtained from eggs collected and incubated at Rockefeller Wildlife Refuge in Grand Chenier, Louisiana, or from wild harvested alligators taken in statewide sanctioned harvests.

Brocklehurst, R.J., Moritz, S., Codd, J., Sellers, W.I. and Brainerd, E.L. (2017). Rib kinematics during lung ventilation in the American alligator (*Alligator mississippiensis*): an XROMM analysis. *Journal of Experimental Biology* 220: 3181-3190.

Abstract: The current hypothesis regarding the mechanics of breathing in crocodylians is that the double-headed ribs, with both a capitulum and tuberculum, rotate about a constrained axis passing through the two articulations; moreover, this axis shifts in the caudal thoracic ribs, as the vertebral parapophysis moves from the centrum to the transverse process. Additionally, the ventral ribcage in crocodylians is thought to possess additional degrees of freedom through mobile intermediate ribs. In this study, X-ray reconstruction of moving morphology (XROMM) was used to quantify rib rotation during breathing in American alligators. Whilst costovertebral joint anatomy predicted overall patterns of motion across the ribcage (decreased bucket handle motion and increased calliper motion), there were significant deviations: anatomical axes overestimated pump handle motion and, generally, ribs *in vivo* rotate about all three body axes more equally than predicted. The intermediate ribs are mobile, with a high degree of rotation measured about the dorsal intracostal joints, especially in the more caudal ribs. Motion of the sternal ribs became increasingly complex caudally, owing to a combination of the movements of the vertebral and intermediate segments. As the crocodylian ribcage is sometimes used as a model for the ancestral archosaur, these results have important implications for how rib motion is reconstructed in fossil taxa, and illustrate the difficulties in reconstructing rib movement based on osteology alone.

Leslie, M. (2017). The case of the macho crocs. *Science* 357(6354): 859-861.

Abstract: Researchers have found a heavily male-biased sex ratio among crocodiles in Palo Verde National Park in Costa Rica. Among hatchlings, males outnumber females by about four to one. However, warming temperatures in that part of Costa Rica should be tilting the sex ratio toward females, the scientists showed. They have also discovered that the animals are contaminated with a synthetic hormone known as 17 α -methyltestosterone, or MT, which may be shifting the sex ratio toward males. MT has some medical uses and is sometimes abused by bodybuilders, but the researchers are

investigating whether the hormone comes from fish farms around the park, which use MT-containing feed to turn female tilapia into males. The scientists are now trying to determine whether MT alters the animals' behavior and whether it is having effects in other locations where crocodiles and fish farms coexist.

Torralvo, K., Botero-Arias, R. and Magnusson, W.E. (2017). Temporal variation in black-caiman-nest predation in varzea of central Brazilian Amazonia. *PLoS ONE* 12(8): e0183476.

Abstract: On the Amazon floodplain, the main predators of black caiman (*Melanosuchus niger*) eggs are jaguars (*Panthera onca*), tegu lizards (*Tupinambis teguixin*), capuchin monkeys (*Sapajus macrocephalus*) and humans (*Homo sapiens*). In this study, we investigated the relationship between predator attacks on nests and incubation period, and evaluated the influence of initial predation on subsequent predation in the Mamirauá Sustainable Development Reserve. We also evaluated the influence of presence of females near the nests and manipulation of nests on the occurrence of attacks. We compared results from data obtained with camera traps and vestiges left by predators on estimates of rates of predation by different predators. Egg predation was recorded in 32% of the 658 black caiman nests monitored during two years. Our results suggest that the probability of predation on black caiman eggs is relatively constant throughout the incubation period and that predation on eggs was lower when adults, presumably females, were present. Careful opening of nests and handling of eggs did not increase the number of attacks on black caiman nests. Nest opening by a predator appeared to increase the chances of a subsequent attack because most of the attacks on nests occurred soon after a predator first opened the nest. However, attacks by another species of predator do not appear to be necessary to initiate attacks by any other species of predator. Results based on camera traps and vestiges differed, but use of vestiges was adequate for identifying the principal predators on eggs in black caiman nests and, in many circumstances, the vestiges may be better for estimating predation by humans. In this study, opening nests and handling eggs did not increase the number of attacks on black caiman nests.

Junker, K. and Mutafchiev, Y. (2017). *Ingwenascaris* n. g. (Nematoda: Ascaridida: Heterocheilidae) established for *I. sprengi* n. sp. and *I. asymmetrica* (Ortlepp, 1932) n. comb., parasites of African crocodiles, and an identification key to the genera of the Heterocheilidae. *Systematic Parasitology* <https://doi.org/10.1007/s11230-017-9748-y>.

Abstract: *Ingwenascaris* n. g. (Nematoda: Heterocheilidae) is established to accommodate *Ingwenascaris sprengi* n. g., n. sp., described from the stomach of *Crocodylus niloticus* Laurenti (Reptilia: Crocodylidae) in South Africa, based on light and scanning electron microscopy studies of its morphology. The new genus can be distinguished from other heterocheilid genera through a combination of its characters, including the pronounced asymmetry of each subventral lip due to an alate ventral margin and a non-alate margin facing the dorsal lip, the presence of continuous ridges of triangular denticles along the free labial margins, the lack of interlocking processes or a rostral plate, interlabia being indistinct or represented by small lateral interlabia between the dorsal and ventral lips only, the absence of prominent interlabial longitudinal cuticular ridges, the presence of lateral alae that are fused with the subventral lips, the presence of lateral caudal alae in both sexes, spicules of males that are composed of handle and alate blade, the presence of a gubernaculum, the number and arrangement of male caudal papillae and the position of the vulva near the anterior and middle third of the body in females. *Ingwenascaris sprengi* n. g., n. sp. represents the sixth heterocheilid genus parasitising African crocodilians. *Trispiculascaris asymmetrica* (Ortlepp, 1932) (syn. *Porrocaecum asymmetricum* Ortlepp, 1932) from a Central African crocodile is transferred to the new genus as *I. asymmetrica* (Ortlepp, 1932) n. comb. The genus *Trispiculascaris* Skrjabin, 1916 is considered a genus *incertae sedis*. An identification key to the genera of the

family Heterocheilidae is presented. This article was registered in the Official Register of Zoological Nomenclature (ZooBank) as BD2D5457-E761-47D6-A405-226AF32C17BE.

Nifong, J.C. and Lowers, R.H. (2017). Reciprocal intraguild predation between *Alligator mississippiensis* (American Alligator) and Elasmobranchii in the Southeastern United States. *Southeastern Naturalist* 16(3): 383-396.

Abstract: The food habits and predatory interactions of *Alligator mississippiensis* (American alligator) have been thoroughly studied within populations inhabiting inland freshwater ecosystems; however, it is increasingly evident that coastal populations habitually forage in estuarine and nearshore marine ecosystems inhabited by other top predators. While few studies have been performed, data reported thus far from marine-foraging populations indicate individuals chiefly consume small-bodied prey such as crustaceans, fish, and wading birds. Nonetheless, capture and consumption of large-bodied marine prey such as multiple species of sea turtles and a single species of Elasmobranchii (sharks and rays) have been documented. Here, we examine evidence regarding reciprocal intraguild predation between American alligators and elasmobranchs. We provide the first evidence of American alligator depredation of 4 Elasmobranchii species and review putative evidence for Elasmobranchii depredation of American alligators. We discuss the ecological significance of these interactions, draw comparisons to similar interactions experienced by other crocodilians, and recommend further avenues for research on the subject.

Barrios, F., Bona, P., Carabajal, A.P. and Gasparini, Z. (2017). Re-description of the cranio-mandibular anatomy of *Notosuchus terrestris* (Crocodyliformes, Mesoeucrocodylia) from the Upper Cretaceous of Patagonia. *Cretaceous Research*.

Abstract: *Notosuchus terrestris* was the first notosuchian described worldwide and the most abundant crocodyliform species in Gondwana during the Late Cretaceous. Here, the lectotype and more than 60 complete and fragmentary specimens were studied allowing the most detailed description of the cranio-mandibular anatomy of this taxon, including poorly known regions as the braincase. Thirty-four characters were described and confirmed by the first time for *Notosuchus*. Possible autapomorphies include: frontal with olfactory tract groove convex posteriorly and with well marked furrows for laterosphenoid, small premaxillary knob fits a maxillary notch in the palate adjacent to the toothrow, small bilobate trigeminal fossa with grooves for the branches the CN V_{SO}, CN V₂ and CN V₃, parietal and laterosphenoid highly pneumatic, post-temporal fenestra obliterated, presence of vestigial quadratojugal spine, ascending process of quadratojugal with posterior groove, vomer lateromedially broad, incisive foramen in heart-shaped delimited by premaxillae and maxillae, and choana with narrow pterygoid septum. We propose a crista pseudo-tuberalis separating the occiput from the braincase wall, as present in some notosuchians. Contrary to previous work, the carotid foramen and the metotic foramen open within a fossa lateral to the occipital condyle, a common feature in advanced notosuchians.

Bercier, M., Heard, D.J., Goe, A.M., Epperson, E., Abbott, J.R., Childress, A.L. and Wellehan, J.F.X. (2017). Granulomatous encephalomyelitis in a False gharial (*Tomistoma schlegelii*) associated with a novel *Chlamydia* species. *J. Zoo Wildl. Med.* 48(2): 563-567.

Abstract: A 5-yr-old, captive, hatched, female false gharial (*Tomistoma schlegelii*) presented with a 1-mo history of cervical spinal curvature. Antemortem diagnostics, including blood work, electromyography, muscle biopsies, and advanced imaging tests, were either within reference ranges or did not identify any specific etiology. Necropsy revealed extensive, marked, chronic

granulomatous encephalomyelitis along with neuronal necrosis, rarefaction, gliosis, and astrocytosis of the white and gray matter of the cerebrum, cerebellum, brainstem, and spinal cord. Pan-chlamydiae polymerase chain reaction protocols for the 16S ribosomal RNA and ompA genes were performed on samples of spinal cord and brain, and both resulted in amplicons. Sequencing of the products revealed that they were positive for a novel *Chlamydia* species. Infections by members of the phylum Chlamydiae have been reported in a diverse range of vertebrate hosts, including crocodilians. *Chlamydia* spp. infections are likely underdiagnosed because of a paucity of diagnostic techniques specific for detection. This is the first case report of a novel *Chlamydia* species associated with severe granulomatous encephalomyelitis in a false gharial.

Haroun-Díaz, E., Blanca-López, N., Vázquez de la Torre, M., Ruano, F.J., Somoza Álvarez, M.L., Labrador Horrillo, M., Bartolomé, B., Blanca, M. and Canto Díez, G. (2017). Severe anaphylaxis due to crocodile-meat allergy exhibiting wide cross-reactivity with fish allergens. *The Journal of Allergy and Clinical Immunology: In Practice* (<https://doi.org/10.1016/j.jaip.2017.07.015>).

Woodyard, E.T., Rosser, T.G. and Rush, S.A. (2017). Alligator wrestling: morphological, molecular, and phylogenetic data on *Odhneriotrema incommodum* (Leidy, 1856) (Digenea: Clinostomidae) from *Alligator mississippiensis* Daudin, 1801 in Mississippi, USA. *Parasitol. Res.* (doi: 10.1007/s00436-017-5607-7)

Abstract: Based on specimens collected from harvested American alligator *Alligator mississippiensis* Daudin, 1801 in Mississippi, USA, novel molecular data for both nuclear ribosomal genes (18S, ITS1-5.8S, ITS2, and 28S) and mitochondrial genes (cytochrome c oxidase subunit 1 and nicotinamide adenine dinucleotide dehydrogenase subunit 1) are provided for *Odhneriotrema incommodum* (Leidy, 1856), a trematode of the family Clinostomidae Lühe, 1901 infecting *A. mississippiensis* and the Florida spotted gar *Lepisosteus platyrhincus* DeKay, 1842. This represents the first sequencing data available for the genus *Odhneriotrema* and the subfamily Nephrocephalinae Travassos, 1928. Additionally, the results of phylogenetic analyses, additional morphometric data, a photomicrograph, and a line drawing supporting the present identification of *O. incommodum* are provided. These data will aid in elucidating the life cycle of *O. incommodum* through molecular identification of larval stages as well as understanding the evolutionary history of Clinostomidae and its subfamilies. Implications for the currently accepted organization of the Clinostomidae are discussed.

Akula, S. and Hellman, L. (2017). The Appearance and Diversification of Receptors for IgM During Vertebrate Evolution. *In* Current Topics in Microbiology and Immunology. Springer: Berlin, Heidelberg.

Abstract: Three different receptors that interact with the constant domains of IgM have been identified: the polymeric immunoglobulin (Ig) receptor (PIGR), the dual receptor for IgA/IgM (FcαμR) and the IgM receptor (FcμR). All of them are related in structure and located in the same chromosomal region in mammals. The functions of the PIGRs are to transport IgM and IgA into the intestinal lumen and to saliva and tears, whereas the FcαμRs enhance uptake of immune complexes and antibody coated bacteria and viruses by B220+ B cells and phagocytes, as well as dampening the Ig response to thymus-independent antigens. The FcμRs have broad-spectrum effects on B-cell development including effects on IgM homeostasis, B-cell survival, humoral immune responses and also in autoantibody formation. The PIGR is the first of these receptors to appear during vertebrate evolution and is found in bony fish and all tetrapods but not in cartilaginous fish. The FcμR is present in all extant mammalian lineages and also in the Chinese and American alligators, suggesting its appearance with early reptiles. Currently

the Fc μ R has only been found in mammals and is most likely the evolutionary youngest of the three receptors. In bony fish, the PIGR has either 2, 3, 4, 5 or 6 extracellular Ig-like domains, whereas in amphibians, reptiles and birds it has 4 domains, and 5 in all mammals. The increase in domain number from 4 to 5 in mammals has been proposed to enhance the interaction with IgA. Both the Fc μ Rs and the Fc γ Rs contain only one Ig domain; the domain that confers Ig binding. In both of these receptors this domain shows the highest degree of sequence similarity to domain 1 of the PIGR. All Ig domains of these three receptors are V type domains, indicating they all have the same origin although they have diversified extensively in function during vertebrate evolution by changing expression patterns and cytoplasmic signaling motifs.

Seah, L.-H., Suadi, Z. and Wee, B.H. (2017). Survival of prey DNA inside a crocodile gut: A review of crocodilian gastric function and accompanying gastric assault. *Journal of Forensic Sciences and Criminal Investigation* 4(3) (doi: 10.19080/JFSCI.2017.04.555642).

Abstract: Examination of the stomach contents of the human scavenging crocodile becomes forensically relevant in the event the missing victim is suspected to fall prey to the carnivore. The exhaustive digestion and harsh acidic stomach of the crocodile is expected to severely compromise the quality and quantity of amplifiable DNA from the remains of the prey. This paper reviewed the physiological events in the stomach of the vertebrate carnivore and the survival of bone DNA from the gastric assault. A case study involving a missing villager suspected to fall prey to a crocodile was tracked to the bones recovered from the stomach of a killed crocodile. DNA genotyping of the bone remains revealed partial profiles by standard STR typing and reinforced the expectation that bone DNA is severely compromised by the harsh digestive enzymes and gastric acid. The utility of a more sensitive DNA identification system such as the AmpFISTR® Minifiler™ Amplification Kit is necessary for DNA identification of the skeletal remains inside a crocodile gut.

Venkatraman, C., Padmanaban, P., Shrinivaasu, S. and Sivaleela, G. (2016). Faunal diversity of Bhitarkanika mangroves, Odisha. *Records of the Zoological Survey of India* 116(4).

Abstract: Bhitarkanika presents a variety of habitats, microhabitat and climatic conditions. Therefore, the faunal component and diversity is also extremely high in comparison to other mangrove forests of South east Coast of India. A total of 420 species belonging to five Phylums under 14 classes (Nematoda, Annelida, Mollusca, Arthropoda and Vertebrates) were recorded during the study period. Among all, bird species were recorded high (264). Though many checklist of faunal species of Bhitarkanika are available, but still there is lacking on the various aspects of ecological studies. A research programme is recommended, to monitor the effectiveness of policies and human-crocodile relationships in the Bhitarkanika, Odisha, in order to minimize human-crocodile conflict in the future.

Stephenson, A., Adams, J.W. and Vaccarezza, M. (2017). The vertebrate heart: an evolutionary perspective. *J. Anat.* (doi: 10.1111/joa.12687).

Abstract: Convergence is the tendency of independent species to evolve similarly when subjected to the same environmental conditions. The primitive blueprint for the circulatory system emerged around 700-600 Mya and exhibits diverse physiological adaptations across the radiations of vertebrates (Subphylum Vertebrata, Phylum Chordata). It has evolved from the early chordate circulatory system with a single layered tube in the tunicate (Subphylum Urchordata) or an amphioxus (Subphylum Cephalochordata), to a vertebrate circulatory system with a two-chambered heart made up of one atrium and one ventricle in gnathostome fish (Infraphylum Gnathostomata), to a system with a three-chambered heart made up of two atria which maybe partially divided or completely separated

in amphibian tetrapods (Class Amphibia). Subsequent tetrapods, including crocodiles and alligators (Order Crocodylia, Subclass Crocodylomorpha, Class Reptilia), birds (Subclass Aves, Class Reptilia) and mammals (Class Mammalia) evolved a four-chambered heart. The structure and function of the circulatory system of each individual holds a vital role which benefits each species specifically. The special characteristics of the four-chamber mammalian heart are highlighted by the peculiar structure of the myocardial muscle.

Siddiqui, R., Jeyamogan, S., Ali, S.M., Abbas, F., Sagathevan, K.A. and Khan, N.A. (2017). Crocodiles and alligators: Antiamoebic and antitumor compounds of crocodiles. *Experimental Parasitology* (https://doi.org/10.1016/j.exppara.2017.09.008).

Abstract: Crocodiles exist in unsanitary environments, feed on rotten meat, are often exposed to heavy metals such as arsenic, cadmium, cobalt, chromium, mercury, nickel, lead, selenium, tolerate high levels of radiation, and are amid the very few species to survive the catastrophic Cretaceous-Tertiary extinction event, nonetheless they can live for up to a 100 years. Moreover, as they live in unhygienic conditions, they regularly come across pathogens. Logically, we postulate that crocodiles have established mechanisms to defend themselves from noxious agents as well as protecting themselves from pathogens. To test this hypothesis, various organ lysates and serum of *Crocodylus palustris* were prepared. Amoebicidal assays were performed using *Acanthamoeba castellanii* belonging to the T4 genotype. Cytotoxicity assays were performed using prostate cancer cells culture by measuring lactate dehydrogenase release as a marker for cell death. Growth inhibition assays were performed to determine the growth inhibitory effects of various organ lysates. Serum and heart lysates of *C. palustris* exhibited powerful anti-tumor activity exhibiting more than 70% prostate cancer cell death (P<0.05). Additionally, lysates from gall bladder and bile also showed significant host cell cytotoxicity, however intestine, lungs and brain showed partial cytotoxicity. Both sera and heart lysates of *C. palustris* abolished prostate cell growth. Moreover, serum completely abolished *A. castellanii* viability. For the first time, these findings showed that the organ lysates of *C. palustris* exhibit potent anti-amoebic and anti-tumor activity. The discovery of antimicrobial and antitumor activity in crocodile will stimulate research in finding therapeutic molecules from unusual sources, and has potential for the development of novel antitumor/antimicrobial compound(s) that may also overcome drug resistance. Nevertheless, rigorous research in the next few years will be necessary to realize these expectations.

Milián-García, Y., Castellanos-Labarcena, J., Russello, M. and Amato, G. (2017). Mitogenomic investigation reveals a cryptic lineage of *Crocodylus* in Cuba. *Bulletin of Marine Science* (doi: https://doi.org/10.5343/bms.2016.1134).

Abstract: The American crocodile, *Crocodylus acutus* (Cuvier, 1807), is the most widely distributed crocodylian in the Americas, and coexists with the endemic and critically endangered Cuban crocodile, *Crocodylus rhombifer* Cuvier, 1807. Although these species are morphologically distinguishable, previous studies have shown that they are more genetically related to each other than either of them are to continental *C. acutus*. Here, we characterize the mitochondrial genome of Cuban *C. acutus* and analyze the resulting data relative to previously published whole mitochondrial genomes to reconstruct patterns of variation and phylogenetic placement within *Crocodylus*. We sequenced 13,776 basepairs, representing 82% of the entire genome including five (COI, COII, ATP8, ND3, ND4L) of the 13 protein-coding genes and 16 of the 22 tRNAs. Independent gene analysis of nucleotide diversity and genetic distance of Tamura-Nei demonstrated that the 16S rRNA, 12S rRNA, and COI genes are the most conserved in *Crocodylus*, while ND6 was the most variable (approximately 9%). Phylogenetic analysis confirmed that Cuban *C. acutus* forms a well-supported sister relationship with *C. rhombifer*, in contrast to continental *C. acutus* that clusters with *Crocodylus intermedius* Graves, 1819. The results are consistent with the hypothesis that Antillean *C. acutus*

represents a cryptic lineage with genetic divergence at the species level. The ability to fully evaluate the taxonomic status of the Caribbean lineage of *C. acutus* still requires more comprehensive population samplings across the range as well as nuclear DNA sequence data. Of more immediate consequence, our results provide important information to be integrated into current *Crocodylus* conservation strategies in Cuba.

Rice, P.M. (2017). Maya crocodilians: Intersections of myth and the natural world at early Nixtun-Ch'ich', Petén, Guatemala. *Journal of Archaeological Method and Theory* (<https://doi.org/10.1007/s10816-017-9352-0>).

Abstract: This essay pursues a four-pronged, interdisciplinary approach in considering the possibility that the unusual layout of the lowland Maya site of Nixtun-Ch'ich' in the lakes region of central Petén, Guatemala, might have been modeled on the scaly back of a crocodile. Part 1 summarizes the biological characteristics of crocodilians, particularly *Crocodylus moreletii*, and their habitats in lowland Mesoamerica. Part 2 reviews interpretations of these reptiles in myth and art, and exploitation of the creature in the lakes area. Third, the ceremonial core of Nixtun-Ch'ich', established in the Middle Preclassic (800-400 BCE) period, is discussed. It exhibits an unusual grid of corridors creating a landscape resembling the bony plates of a crocodilian's back, and a natural cenote-like fosa is proposed to relate to a mythical "Starry Deer Crocodile." Part 4 discusses probable social and political characteristics of early community leaders who planned this site's atypical layout, viewed through selectionist theories of cooperation and costly signaling. Designed to mimic the mythical crocodile of creation, Nixtun-Ch'ich' illustrates the role of ideological power in the development of complex societies.

Balaguera-Reina, S.A., Venegas-Anaya, M., Rivera-Rivera, B. and Densmore III, L.D. (2017). Scute patterns as an individual identification tool in an American crocodile (*Crocodylus acutus*) population on Coiba Island, Panama. *Journal of Herpetology* 51(4): 523-531.

Abstract: Identification of individuals based on morphological patterns is a strategy used primarily in human forensics that has also been applied successfully in several wildlife scenarios. To date, no study has evaluated the potential of these techniques on American crocodiles (*Crocodylus acutus*). We assessed whether the dorsal scute number and pattern of 110 American crocodiles captured from the wild on Coiba Island, Panama could be used for individual recognition. We estimated scute variation using the number and position of scutes, testing both a binary and a coded assessment for scute presence and pattern, respectively. We analyzed scute patterns using 21 transverse scute lines (TSL) including the three most prominent scutes present on each side of the vertebral column axis. We found significant differences in the number of scutes per TSL and longitudinal scute lines (LSL) by individual. Based on both the binary and coded analyses, we identified all American crocodiles assessed at the individual level, using only the first 13 and 10 TSL, respectively, in an anterior-posterior direction. This gave us a minimum probability of ≤ 0.0003 based on the coded analysis and $\leq 2.02 \times 10$ based on the binary analysis to find pattern repetition (one out of 3333 and one out of 49,504 American crocodiles have the most-common scute pattern, respectively). Because the *C. acutus* total population of Coiba Island has been estimated as no more than 1000 individuals, we could use this individual identification pattern recognition method (IIPR) to identify every American crocodile inhabiting this island.

Joanen, T. and Merchant, M. (2017). *Alligator mississippiensis* (American Alligator). Reproduction. *Herpetological Review* 48(3): 625-626.

Eversole, C.B. and Henke, S.E. (2017). *Alligator mississippiensis* (American Alligator). Neoplasia. *Herpetological Review* 48(3): 626-627.

Coulson, J.). and Coulson, T.D. (2017). *Alligator mississippiensis* (American Alligator). Diet. *Herpetological Review* 48(3): 627.

Elsey, R.M., Ledet, E. and Carter, J. (2017). *Alligator mississippiensis* (American Alligator). Novel Non-native Prey. *Herpetological Review* 48(3): 627-628.

Platt, S.G. and Elsey, R.M. (2017). *Alligator mississippiensis* (American Alligator). Feeding Aggregation and Behaviour. *Herpetological Review* 48(3): 628-629.

Tellez, M., Heflick, S. and Boucher, M. (2017). *Crocodylus moreletii* (Morelet's Crocodile). Cannibalism. *Herpetological Review* 48(3): 629-630.

Samarasinghe, D.J.S. and Alwis, D. (2017). *Crocodylus porosus* (Saltwater Crocodile). Diet. *Herpetological Review* 48(3): 630-631.

Macdonald, C., Gallagher, A.J., Barnett, A., Brunnschweiler, J., Shiffman, D.S. and Hammerschlag, N. (2017). Conservation potential of apex predator tourism. *Biological Conservation* 215: 132-141.

Abstract: In recent decades, public interest in apex predators has led to the creation and expansion of predator-focused wildlife tourism. As wildlife tourism has become an increasing topic of study for both social and biological scientists, researchers have debated whether these activities serve conservation goals by providing non-consumptive values for wildlife. Discussion of predator tourism requires additional recognition of predator-specific biological and ecological characteristics, consideration of human safety concerns, and mitigation of human-wildlife conflict. By reviewing tourism activities centered on both aquatic and terrestrial predators from diverse taxa (sharks, crocodiles, and big cats), we evaluate the potential benefits and conservation challenges associated with predator tourism. Our review suggests that positive conservation outcomes are possible, but not assured given historical, cultural, and ecological complexities. We explore some of the factors which determine whether tourism contributes to conservation outcomes, including (1) effective protection of animals and habitats, (2) avoidance and mitigation of human-wildlife conflict, (3) quality of associated educational interpretation and outreach, (4) collaboration with local stakeholders, and (5) use of generated funds to advance conservation goals. Our findings suggest tourism is most likely to support predator conservation and/or recovery when the industry has both public and political support and under conditions of effective regulation focused on management, monitoring and enforcement by local, national, and international bodies.

Edwards, T.M., Hamlin, H.J., Freymiller, H., Green, S., Thurman, J. and Guillet, Jr., L.J. (2018). Nitrate induces a type 1 diabetic profile in alligator hatchlings. *Ecotoxicology and Environmental Safety* 147: 767-775.

Abstract: Type 1 diabetes (T1D) is a chronic autoimmune disease that affects 1 in 300 children by age 18. T1D is caused by inflammation-induced loss of insulin-producing pancreatic beta cells, leading to high blood glucose and a host of downstream complications. Although multiple genes are associated with T1D risk, only 5% of genetically susceptible individuals actually develop clinical disease. Moreover, a growing number of T1D cases occur

in geographic clusters and among children with low risk genotypes. These observations suggest that environmental factors contribute to T1D etiology. One potential factor, supported primarily by epidemiological studies, is the presence of nitrate and nitrite in drinking water. To test this hypothesis, female hatchling alligators were exposed to environmentally relevant concentrations of nitrate in their tank water (reference, 10 mg/L, or 100 mg/L $\text{NO}_3\text{-N}$) from hatch through 5 weeks or 5 months of age. At each time point, endpoints related to T1D were investigated: plasma levels of glucose, triglycerides, testosterone, estradiol, and thyroxine; pancreas, fat body, and thyroid weights; weight gain or loss; presence of immune cells in the pancreas; and pancreatic beta cell number, assessed by antibody staining of nkx6.1 protein. Internal dosing of nitrate was confirmed by measuring plasma and urine nitrate levels and whole blood methemoglobin. Cluster analysis indicated that high nitrate exposure (most animals exposed to 100 mg/L $\text{NO}_3\text{-N}$ and one alligator exposed to 10 mg/L $\text{NO}_3\text{-N}$) induced a profile of endpoints consistent with early T1D that could be detected after 5 weeks and was more strongly present after 5 months. Our study supports epidemiological data correlating elevated nitrate with T1D onset in humans, and highlights nitrate as a possible environmental contributor to the etiology of T1D, possibly through its role as a nitric oxide precursor.

Buzzi, S. and Zanforlini, C. (2017). Healing with dung: The crocodile. *Journal of History of Medicine* 29(2).

Abstract: Animal dung has always been used as part of medicines; even if magic played an important role in ancient medicine, doctors of past centuries have considered for centuries dung as an effective drug. This paper discusses the use of excrements in ancient Egyptian, Greek, Roman and Byzantine medicine, in particular crocodile dung. Crocodile were familiar animals for those who lived along the Nile, but with Ptolemaic era, also the Greeks (and then the Romans) became acquainted with this reptile, also cosmetically and from a medical point of view.

Waddle, H. (2017). 2017 Coastal Master Plan: Attachment C3-10: Alligator, *Alligator mississippiensis*, Habitat Suitability Index Model. Louisiana Coastal Protection and Restoration Authority: Baton Rouge.

Abstract: The 2012 Coastal Master Plan utilized Habitat Suitability Indices (HSIs) to evaluate potential project effects on wildlife species. Even though HSIs quantify habitat condition, which may not directly correlate to species abundance, they remain a practical and tractable way to assess changes in habitat quality from various restoration actions. As part of the legislatively mandated five year update to the 2012 plan, the wildlife habitat suitability indices were updated and revised using literature and existing field data where available. The outcome of these efforts resulted in improved, or in some cases entirely new suitability indices. This report describes the development of the habitat suitability indices for the American alligator, *Alligator mississippiensis*.

Chagas, D.C. da (2017). Aspects of Hunting and Trade of Alligator (Crocodylia: Alligatoridae) on the Copeá River, in the Municipality of Maraã (Am). Thesis, Universidade do Estado do Amazonas Repositorio Institucional UEA (<http://repositorioinstitucional.uea.edu.br/handle/riuea/599>).

Abstract: Hunting of caimans occur over all Amazon basin but are a few studies about this theme. This research was conducted in order to characterize aspects of hunting and trade of alligator meat in Copeá River, taking as a production base, two communities located the banks of this river. The information in this article was obtained through interviews and monitoring landing in the port community. The measures of body size were obtained, weight, species, sex, origin, methods and effort hunting, selling price and destination

of the meat. In 12 hunting events, representing 8 days of effort, 35 *M. niger* and six *C. crocodilus* were captured. Males was the most hunted than the females. Canoe with "rabeta" was the most utilized to go hunting and harpoon was the unique method utilized to hunting caimans. The average yield per hunter/night was 118 kg of salted/dry meat which yields R\$294.50. The meat is sold salted/dried, for \$2.50 a pound and is for the market of Para State.

Findsen, A., Crossley, D. and Wang, T. (2017). Feeding alters blood flow patterns in the American alligator (*Alligator mississippiensis*). *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* (<https://doi.org/10.1016/j.cbpa.2017.09.001>).

Abstract: The crocodilian cardiovascular design with a four-chambered heart and a left aorta that emerge from the right ventricle allows blood to be shunted away from the lungs, a right-to-left (R-L) shunt. The adaptive significance of this R-L shunt remains both poorly understood and controversial with particular debate on its putative role during digestion. Here we measure blood flow patterns in the right aorta (RAo), left aorta (LAo) and the coeliac artery (CoA) of undisturbed American alligators (*Alligator mississippiensis*) during fasting and throughout most of the digestive period. Digestion doubled blood flow in the RAo (10.1 ± 0.9 to 20.7 ± 1.5 $\text{ml min}^{-1} \text{kg}^{-1}$), whereas LAo increased approximately 3-fold (3.8 ± 0.6 to 12.2 ± 2.1 $\text{ml min}^{-1} \text{kg}^{-1}$). Blood flow in the CoA increased more than four-fold during digestion (3.0 ± 0.6 to 13.3 ± 1.6 $\text{ml min}^{-1} \text{kg}^{-1}$). The rise in blood flows was achieved by a doubling of heart rate (18.5 ± 3.3 to 37.8 ± 3.6 $\text{min}^{-1} \text{kg}^{-1}$). Maximal flows measured in all arteries and heart rate occurred in the first hour of the postprandial period and continued for the next 7 hours.

Lapbenjakul, S., Thapana, W., Twilprawat, P., Muangmai, N., Kanchanaketu, T., Tamsiripong, Y., Unajak, S., Peyachoknagul, S. and Srikulnath, K. (2017). High genetic diversity and demographic history of captive Siamese and Saltwater crocodiles suggest the first step toward the establishment of a breeding and reintroduction program in Thailand. *PLoS ONE* 12(9): e0184526.

Abstract: The Siamese crocodile (*Crocodylus siamensis*) and Saltwater crocodile (*C. porosus*) are two of the most endangered animals in Thailand. Their numbers have been reduced severely by hunting and habitat fragmentation. A reintroduction plan involving captive-bred populations that are used commercially is important and necessary as a conservation strategy to aid in the recovery of wild populations. Here, the genetic diversity and population structure of 69 individual crocodiles, mostly members of captive populations, were analyzed using both mitochondrial D-loop DNA and microsatellite markers. The overall haplotype diversity was 0.924-0.971 and the mean expected heterozygosity across 22 microsatellite loci was 0.578-0.701 for the two species. This agreed with the star-like shaped topology of the haplotype network, which suggests a high level of genetic diversity. The mean ratio of the number of alleles to the allelic range (M ratio) for the populations of both species was considerably lower than the threshold of 0.68, which was interpreted as indicative of a historical genetic bottleneck. Microsatellite markers provided evidence of introgression for three individual crocodiles, which suggest that hybridization might have occurred between *C. siamensis* and *C. porosus*. D-loop sequence analysis detected bi-directional hybridization between male and female individuals of the parent species. Therefore, identification of genetically non-hybrid and hybrid individuals is important for long-term conservation management. Relatedness values were low within the captive populations, which supported their genetic integrity and the viability of a breeding and reintroduction management plan. This work constitutes the first step in establishing an appropriate source population from a scientifically managed perspective for an in situ/ex situ conservation program and reintroduction of crocodile individuals to the wild in Thailand.

Submitted Publications

CUVIER'S *CROCODYLUS NILOTICUS* LAURENTI NEOTYPE. Figure 1 (on plate 3) in Cuvier (1807) was not the first reasonably truthful and informative illustration of a whole (snout tip to tail tip) crocodilian, because some of the pictures in Seba's famous "Thesaurus" (vol. 1, pls. 103-105, but definitely not plate 106) were close enough to reality in 1734 to be of scientific interest, particularly plate 105 (figures 3 and 4). However, plate 3 in Cuvier (1807) was the first picture of a whole Nile crocodile that was biologically accurate, because none of the plates 103-105 crocodilians in Seba (1734) were the Egyptian crocodile, and further [and as explained in Cuvier (1807)] all of the various pictures of the whole (lateral and dorsal view) Nile crocodile that had been published before 1807 were each individually flawed, often by being misleadingly stylized.

The Cuvier (1807) plate 3 figure 1 was reproduced in Ross and Kischlat (2015), which convincingly argued that this published illustration (and its provenance and physical specimen) has long and prominently functioned as the primary example of Cuvier's Nile crocodile. This was Cuvier's (1807) crocodile of the ancient Ionian Greeks (krokodēilos), and the species which unfortunately suffered the loss of its name *Crocodylus niloticus* because Laurenti (1768) had based that noble and informative binomen on two specimens that are actually and embarrassingly identifiable today (and also by Cuvier 1807) as South American smooth-fronted caimans (Subfamily Caimaninae). In contrast, the crocodile of the Egyptian Nile is not in the alligatorid family, but rather in the Crocodylidae that has the genus *Crocodylus* Laurenti, 1768, as its eponym, based on the Nile crocodile of Africa.

Cuvier (1807) described the Egyptian Nile crocodile species as ontogenetically variable yet distinctive and identifiable at each of its various sizes in head shape and in the details of its whole body coloration, while the numbers of teeth and the dorsal scalation remain constant throughout life, and the observed and reported characters presented by Cuvier (1807) served to distinguish this individual species from its congeneric *C. siamensis*, *C. palustris*, *C. porosus*, *C. rhombifer* and *C. acutus*, and from the other living crocodilian genera and species as well. Further, although essentially ubiquitous within the crocodiles as a whole, the diagnostic holes or bony "fenestrae" in the skeletonized head, and the external sutures amongst many cranial and mandibular bones of the "Crocodile vulgaire ou d'Afrique" were shown in figures 5 and 12 in plate 1 in Cuvier (1807).

Cuvier (1807) also included the Nile crocodile species as having the crocodilian lengthwise cloacal opening on its flat and essentially boneless "belly" surface that is generally paved with relatively large rectangular scales, and his wild crocodile of Egypt exhibited five fingers (only the proximal three with one claw each) and four clearly visible toes (only the proximal three digits clawed). In addition to his whole animal in dorso-lateral view, and in addition to his two pictures of the bony skull and articulated lower jaws of this species, there was also Cuvier's (1807) plate 2, figure 7 ("Crocodile vulgaire") illustration which showed the details of the neck and its adjacent thoracic body armor in a proper dorsal view. However, the specimen partly depicted in figure 7 (plate 2) was without detailed provenance, as was or were the illustrated skull(s) in plate 1, and today I am sure that the plate 2 neck picture is not the same individual animal as the whole *C. vulgaris* lectotype creature in plate 3.

Also, I am convinced from selected details and the physical sizes of the Nile crocodiles that the two whole animal latero-dorsal figures depicted in Geoffroy-Saint-Hilaire (1826) were not either of the 1807, plate 3 individual. Thus, it appears clear that the single and only illustration of the lectotype of *Crocodylus vulgaris* Cuvier, 1807, is the original figure 1 on plate 3 in volume 10 of the Annales du Muséum, which is the picture recently reprinted in Ross and Kischlat (2015).

In its Recommendation 74B (preference for illustrated specimen),

the International Commission on Zoological Nomenclature's (1999) "Code" suggests that when a zoologist is selecting a single specimen (or published picture of a specimen) to become the lectotype of a species-group name, he or she "should give preference to a syntype of which an illustration has been published"; and, in its main text it had been explained that "designation of an illustration or description of a syntype as a lectotype is to be treated as designation of the specimen illustrated or described; the fact that the specimen no longer exists or cannot be traced does not of itself invalidate the designation" (Art. 74.4).

By analogy to the principles and rules for lectotypes, for the same basic reasons consideration should also be given to a specimen of which a published (and accurate and informative) illustration is available when declaring a neotype for a biological species-group taxon. The present example is the Ann. Mus. X, pl. 3, fig. 1 picture with trustworthy provenance. The germane story is known all the way from the wild crocodile being collected around 1799 or 1800 near Luxor in Egypt, to its head and skin being stuffed by a taxidermist in Paris, and then illustrated and the picture published in 1807 as the specimen that Étienne Geoffroy-Saint-Hilaire personally brought home from Egypt, namely the plate 3, figure 1 whole (presumably stuffed) animal.

The Code's publication requirements for a neotype are the same as for species-group names and for lectotypes. The periodical or book must be held in at least six libraries and thereby the nomenclatural act becomes publicly announced to the relevant scientific community. Surely the Annales du Muséum d'Histoire Naturelle qualifies. Additionally a neotype designation as a nomenclatural action especially requires that its author explains the various circumstances that cumulatively result in the firm conclusion that the name in question lacks a type or lectotype (or conceivably a prior neotype), and is similarly devoid of syntypes or paralectotypes.

Cuvier (1807) explained that absurdly *Crocodylus niloticus* had accidentally and wrongly been based on Seba's (1734) pictures of two (plate 105, figures 3-4) South American baby smooth-fronted caimans. Further correctly, he also vehemently complained that the Nile crocodile content in *Lacerta crocodilus* Linnaeus had been eclipsed by the specimen described in detail in 1746 in Sweden. This individual with an interocular ridge on its head, and with a longitudinal cloacal opening, is clearly identifiable today (and was identified by Cuvier) as the spectacled caiman that is common at Paramaribo in Suriname, and at Cayenne in French Guiana. Also Cuvier (1807) reviewed the suite of important germane published works on the subject of the crocodiles of the world, and he concluded that most of the existing descriptions and illustrations were defective or wanting in some way or another. Many of the scientific names were based on conflicting animals (at today's subfamily and family levels), and the theoretically significant eponymic derivation of the individual iconic and long known Nile crocodile (through *Lacerta crocodilus* in 1758, and *Crocodylus niloticus* in 1768) had become compromised.

In its wisdom the 1999 Code stresses that an author should not designate a neotype for the simple and single purpose of doing it. Rather, the zoologist who creates a neotype specimen for a species-group name must have had some clearly larger taxonomic schema into which this new development fits and serves some good purpose. It seems that there must be a need for the type-locality that the neotype brings to the name in question, and that the neotype itself should be from as close as possible to the place originally denoted or indicated in any way by the name's original author. In other words, if Laurenti (1768) called the species *C. niloticus* with Sri Lanka (from Seba) and Egypt (from Laurenti) as its distribution, then the best neotype would be from the Nile River in Egypt (Laurenti's addition), and collected from the wild in 1799 or 1800 near Luxor (and also near but not actually at the dry archaeological site of ancient Thebes) is as good a specific provenance place as any.

For a neotype, the 1999 Code requires "a statement that it is

designated with the express purpose of clarifying the taxonomic status or the type locality of a nominal taxon” (Art. 75.3.1). This kind of clarification was needed in 1807 because *C. niloticus* (in today’s Crocodylidae) of Africa had South American syntypes (from the Alligatoridae) in error. The importance of the Nile crocodile of Egypt as the most true crocodile (because this species had been known the longest and reported both correctly and incorrectly the most often) was detailed by quotes and comments that continue from pages 40 to 53 of literary citations (including Arabic, Persian and Greek) pertaining directly and individually to the crocodile of Egypt in Cuvier (1807).

The context in which Cuvier (1807) found it necessary to establish a new species-group name for the crocodile of the Nile was noble, timely and honest. He was sincerely working on the behalf of his scientific colleagues and community when he discovered that the crocodile of Egypt needed a new specimen base, because the existing old framework for the living Crocodylia as a collective group (including the Gavialidae) was chaos, as detailed in his judiciously skeptical digest of scholarly European publications on pages 11-23.

Recently an article by Savage (2017) quoted and favorably discussed the suggestion in Van Tomme *et al.* (2015) that the lectotype of *C. vulgaris* should be designated as simultaneously being the neotype of *C. niloticus*, thereby making *Crocodylus* Cuvier and *Crocodylus* Laurenti become absolute synonyms because they are respectively and individually based on type-species which share the exact same single type specimen (in this case the Ann. Mus. X, pl. 3, fig. 1 illustration and its physical animal and its locality data and other provenance).

Savage (2017) correctly observed that for the ICZN to perform any action, someone must submit a petition to the International Commission on Zoological Nomenclature upon which they can act in response. He urged me to pursue this matter, and now the guidelines for submitting a case to the ICZN through its Bulletin of Zoological Nomenclature magazine have been consulted, and they say that “if the plenary power of the Commission is sought, this necessity should be clearly explained (with reference to the relevant Articles of the Code)” and the instructions direct an author to “in cases dealing with neotypes give the details of the neotype proposed (to comply with the requirements of the Code)” (item iii).

In the past it had been my impression that somehow the ICZN was the only route to the creation of a neotype, but I was wrong. Rather and surprisingly to the contrary, it is actually the case that any author can designate a neotype, but when a neotype needs to be set aside and must be replaced by a different specimen, then the ICZN must perform the action. The ICZN (1999) Code in its Art. 75.4 (priority) says that “the first neotype designation published for a nominal species-group taxon in accordance with the provisions of this Article is valid and no subsequent designation except one made by the Commission under the plenary power [Art. 78.1], has any validity (also see Article 75.8 for the status of a neotype if a former name-bearing type is rediscovered)”.

Cuvier (1807) was the result of his efforts to see exactly what kinds and degrees of differences occur at the species and genus levels in the living Crocodylia, because he had examined and had read about fossil crocodile skulls, mandibles and postcranial bones being found famously in England and then also (and sometimes the same species) in Germany first, and then Belgium and France. This was for Cuvier perplexing, and he worked to associate the heads with their vertebrae, and he needed to understand things that were not then known.

Not understood in 1807 was the question of why and how the skeletons of these tropical reptiles got to the northern temperate zone of western Europe, and relatedly (because this was so long before Charles Darwin’s book) that the problem encountered by Georges Cuvier (namely Evolution and Continental Drift) required of him that he understand the living examples. The revision in

Cuvier (1807) was not one of vanity, but rather was a case of good sense and justifiable reasons.

It was correct that Cuvier (1807) consciously replaced the vernacular French names from Lacépède (1788) with binominal latinized names in the Linnean tradition. Separately and very popularly and influentially, the I-spelling *Crocodylus* of Lacépède (1788), which was an alternative spelling with explicitly the exact same meaning as the earlier Y-spelled *Crocodylus* of Laurenti (1768), had the Nile River crocodile of Egypt as its eponym (krokodeilos in Ionian Greek) animal. Thus, it turns out that Cuvier (1807) was very much in agreement with the standard and broadly based assertion and understanding that the genus *Crocodylus* Laurenti, 1768, was based on *C. niloticus* Laurenti, and that the *Crocodylus* spelling of Lacépède and of Cuvier (and of selected others) was also and equally based on the same Nile crocodile.

Recommendation 75B (consultation with specialists) says that “before designating a neotype, an author should be satisfied that the proposed designation does not arouse serious objection from other specialists in the group in question” (ICZN, 1999). Today everybody agrees that the binomen *Crocodylus niloticus* denotes the Nile crocodile of Africa, and in doing that we all are rejecting the Werner (1933) model of calling the modern South American endemic genus of smooth-fronted caimans (today’s *Paleosuchus*) as *Crocodylus* Laurenti, 1768, and the current two species as *Crocodylus niloticus* (the *Paleosuchus trigonatus* one), and *Crocodylus palpebrosus*.

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