CROCODILE SPECIALIST GROUP NEWSLETTER

VOLUME 38 No. 2 • APRIL 2019 - JUNE 2019

IUCN • Species Survival Commission

CROCODILE

SPECIALIST

GROUP

NEWSLETTER

VOLUME 38 Number 2
APRIL 2019 - JUNE 2019

IUCN - Species Survival Commission

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

EDITORIAL AND EXECUTIVE OFFICE:
PO Box 530, Karama, NT 0813, Australia

COVER PHOTOGRAPH: Juvenile Chinese alligator (*Alligator sinensis*), Zheijiang Province, China. Photograph: Lan Zhao.

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

CSG Newsletter

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

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

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

PATRONS

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

Big Bull Crocs! ($15,000 or more annually or in aggregate donations)
Japan Leather & Leather Goods Industries Association, CITES Promotion Committee & Japan Reptile Leather Industries Association, Tokyo, Japan.
Heng Long Leather Co. Pte. Ltd., Singapore.
Reptile Tannery of Louisiana, Lafayette, Louisiana, USA/ Hermes Cuirs Precieux, Paris, France.
Singapore Reptile Skin Trade Association, Singapore.
United Leather Products Co., Ltd. and Nakorn Sawan Crocodile Farm, Thailand.

Friends ($3000 - $15,000)
Coral Agri-Venture Farm, Philippines.
Crocodilian Advisory Group, Association of Zoos and Aquariums, USA.
Enrico Chiesa, Italhide, Italy.
Donald Farms, Louisiana, USA.
Jake Puglia, Alligator Adventures, USA.
Mainland Holdings, Lae, Papua New Guinea.
Phillip Cunliffe-Steel, New Zealand.
Sam Seashole, Crocodile Conservation Institute, USA.
St. Augustine Alligator Farm, Florida, USA.
Wall Family/Wall's Gator Farm II, Louisiana, USA.
Wayne Sagrera, Vermilion Gator Farm, Louisiana, USA.
Virginia Aquarium and Marine Science Center Foundation, Virginia Beach, Virginia, USA.

Supporters ($1000 - $3000)
Bjorneparken Zoo, Flå, Norway.
Simone Comparini, Pantera S.R.L., S. Croce s/Arno, Italy.
Crocodile Cooperative of Thailand and Crocodile Management Association of Thailand, Thailand.
Ebey family, New Mexico, USA.
FunCroco, Cartagena, Colombia.
Louisiana Alligators Farmers and Ranchers Association, Abbeville, Louisiana, USA.
Phoenix Herpetological Society, Arizona, USA.
Paolo Martelli, Hong Kong.

R.J. Rao, Gwalior, India.
George Saputra, CV Alona Jaya, Jakarta, Indonesia.
J.K. Mercado & Sons Agricultural Enterprises, Philippines.
Zambia Crocodile Farmers Association, Lusaka, Zambia.

Contributors ($250 - $1000)
Allan Woodward, Florida, USA.
Cathy Shilton, Northern Territory, Australia.
Croc Encounters of Tampa, Florida, USA.
Lou Densmore, Texas, USA.
Dresden Zoo, Dresden, Germany.
Richard Fergusson, Mozambique.
James Hennessy, The National Reptile Zoo, Ireland.
Libor Kopecny, Czech Republic.
Jeff Lang, Minnesota, USA.
Matthew Shirley, Florida, USA.
Zoo Atlanta, Georgia, USA.
Zoological Society of Hertfordshire, UK.

Editorial

The possibility that California may ban all trade in crocodilian products remains [see Editorial, CSG Newsletter 38(1)]. In April I undertook a second trip to California to add support to a proposed new Bill (AB527), aimed at removing the threat, and which passed the first committee stage. But so too did another Bill (AB1260), banning trade in caimans and selected lizards and snakes! Supporters of these bans are largely animal rights groups, which do not appear to understand the broader ramifications that a ban would have on conservation, livelihoods or the economies of producing states. The Louisiana Government and farmers are tracking this issue closely, because the full Assembly and Senate need to review it, so it remains an ongoing issue.

Added to this, in Mexico, legislation has been proposed that would ban national trade in exotic skins, including crocodilians. Again, this is based on animal rights ideologies, and it seems to ignore the ramifications of such a ban to conservation, livelihoods and the economy, where Mexico is a major leather manufacturing centre. The proposed changes to the Ley General de Vida Silvestre (Wildlife Law) would prohibit import, export and re-export of animals and parts of exotic species for use in the fashion industry or commercial use generally, with all products of these skins to be removed from the market by 2021. We understand that significant representation is being made by both conservation and industry groups opposed to this legislation.

At a global level, there seems to be a renewed push by animal rights groups to simply stop the use of exotic animals in trade worldwide. The arguments used are quite tortuous, poorly based in real evidence and often containing deliberate distortions of the truth. For example, there is now a serious focus on science-based animal welfare within large segments of the crocodilian farming industry. This trend is ignored in favour of using cherry-picked images of practices that are bad, or appear to be bad to the untrained eye, to typify the industry. A real case of focusing attention on a few selected trees rather than on the forest.

Many CSG members who were intending to participate in CITES CoP18 (Colombo, Sri Lanka; 21 May-4 June 2019), have had to alter plans when the meeting was postponed in the wake of terrorist attacks on churches and hotels on 21 April 2019. The revised meeting venue and dates have now been confirmed by the CITES Secretariat, and CoP18 will be held in Geneva, Switzerland, 17-28 August 2019. The direct cost of postponement of CoP18 to the CSG, which was assisting some members of the Future Leaders Program to attend, was estimated to be around $US3600.

"SSC DATA" is the new annual reporting format for all SSC specialist groups. It is hoped that this can assist the SSC to improve its ability to track and integrate information on strategic plans and activities, and better understand the needs of the SSC network (see 2017-2020 Species Strategic Plan; https://www.iucn.org/sites/dev/files/content/documents/ssc-iucn-components-a4-digital_0.pdf). The CSG Annual Report to the SSC was submitted on 22 April 2019, and I would like to thank all those members who provided photographs for the SSC to select and use in its annual report.

I attended the CSG Central America & Caribbean Sub-regional Meeting, held in Belize, on 26-29 June 2019. Some 80 participants from 19 countries attended what was a seriously good meeting, focused on research and monitoring being undertaken in the region by a diversity of excellent researchers. Highlights were the results of the Belize national survey program which confirmed a very significant recovery of the *C. moreletii* population had taken place. The Government of Belize needs to be congratulated for its long-standing efforts to protect and conserve crocodiles. A detailed summary will be provided in the July-September issue of the CSG Newsletter.

Summer CrocFest, held in June 2019, and hosted by Zoo Miami, was again a serious success story, raising $US30,275 which will support research on the American crocodile (*Crocodylus acutus*), by 5 researchers in 5 countries (USA, Belize, Costa Rica, Colombia, Guatemala) (see page 12 for details).

Professor Grahame Webb, *CSG Chair.*

CSG Student Research Assistance Scheme

The Student Research Assistance Scheme (SRAS) provided funding to two students in the April-June 2019 quarter. Two further application are under consideration.

1. Felix Thirion (Belgium): Assessing patterns of heavy metal accumulation in *Crocodylus moreletii* and *Crocodylus acutus* sub-populations in Belize.

2. Terry Mougnard (France): Study of scales patterns of *C. acutus* and *C. moreletii* in South East of Mexico.

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

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

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

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

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

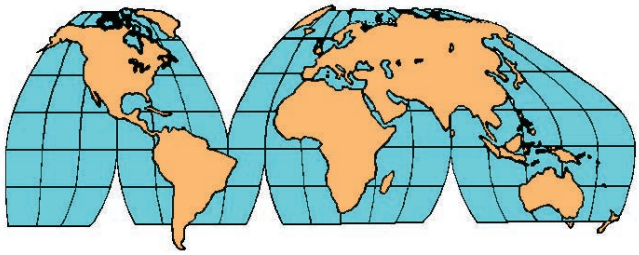
Music Inspired by World Crocodilians

Musician and composer Francisco Lozano, from Mexico City, Mexico, and who performs as "Drilo", has written 24 songs, one for each species of crocodilian. Through the music he has tried to reflect the places where these crocodilians live. For example, the composition for the Nile crocodile is inspired by Egyptian music, the one for Mexico's Morelet's crocodile has Mexican music motifs in it, and so forth.

When Drilo plays these compositions in concert, he tells the audience interesting facts about these species. His most recent concert was at Mexico City's Museum of Natural History.

The album "Crocodylia" is available on various music-listening platforms. Search for the album name (Crocodylia) and artist (Drilo) on Spotify, Apple Music, iTunes, Amazon Music and Deezer. Search for "Drilo Topic" on Youtube.

Regional Reports



South Asia and Iran

India

NOTE ON INTERACTIONS BETWEEN PREDATORS AND PREY: INDIAN CROCS AND BIRDS. The interactions between predators and prey have a long evolutionary history, with each developing heightened survival abilities and adaptations with time, in order to detect the other's presence and relevant associations with nature (Magurran and Seghers 1990). Crocodilians are exclusively carnivorous, and occur as dominant predators in aquatic ecosystems (Lang 2002). Numerous studies emphasize the role of crocodilians as predators, but few studies deal with the role of crocodilians as prey (Somaweera *et al*. 2013).

Somaweera *et al*. (2013) reviewed predators of crocodilians, and provides accounts from 19 crocodilian species, with 184 invertebrate (insects and crustaceans) and vertebrate (fish, amphibians, reptiles, birds and mammals) predators. For the Mugger (*Crocodylus palustris*) and Saltwater crocodile (*C. porosus*), 16+ and 11+ predator species respectively, were reported to impact on different life history stages of these two crocodile species (Table 1). Here, we report on birds predating on *C. palustris* and *C. porosus* in India.

Crocodylus palustris: On 25 June 2017, an adult Purple heron (*Ardea purpurea*) was sighted from a distance holding prey in its beak, along the banks of the Chambal River, in the Palighat area (Palighat, Khandar, Sawai Mādhopur). It was initially difficult to identify the prey item, but its jerking movements were clearly visible. Upon more careful examination, the prey was confirmed as a 22-25 cm long Mugger hatchling (Fig. 1). After 15-20 minutes of struggling, the hatchling was consumed by the bird.

The Purple heron is a large, wide-ranging wader, that has a diverse diet comprising insects, crustaceans, molluscs (water snails), fish, small mammals, amphibians, nestlings or small birds and reptiles, including snakes and lizards (Johnson 1988; Martínez-Vilalta and Motis 1992; Kushlan and Hancock 2005).

On 12 March 2019, Mr. D.K. Sharma recorded an "aggressive" interaction between a Saras crane (*Grus antigone*) and a 1+ m long Mugger (Fig. 3) at a small wetland near Abheda Mahal (25°12'0.97" N; 75°47'20.87" E), Kota City, Rajasthan, India.

Figure 1. Adult Purple heron holding a hatchling Mugger in its beak. Photograph: Rudrapratap Singh Rajawat.

Figure 2. Interaction between an adult Saras crane and a sub-adult (1+ m) Mugger. Photograph: Devendra Kumar Sharma.

The Mugger and Saras crane are sympatric wetland species, sharing habitat and distribution range. Observations of comparatively smaller waders, such as Black-necked stork (*Ephippiorhynchus asiaticus*), Painted stork (*Mycteria leucocephala*) (Somaweera *et al*. 2013) and Purple heron (see above), suggest that larger species such as Saras cranes are potential predators of small Muggers.

Crocodylus porosus: On 5 February 2019, a group of wildlife photographers visiting Bhitarkanika Wildlife Sanctuary, Orissa, sighted a large raptor in flight, holding live prey in its talons. A photograph taken at the time was used to identify the bird as a White-bellied sea eagle (*Haliaeetus leucogaster*), and the prey as a 70-80 cm long crocodile (Fig. 2). As only *C. porosus* occurs in the area, the prey was assumed to be this species.

The White-bellied Sea-Eagle is a coastal raptor that is widely distributed across the coastal peripheries of India, Sri Lanka, South East Asia, Philippines, New Guinea and Australia (Ferguson-Lees and Christie 2001; Grimmett *et al*. 2011). It has been reported to feed on various reptiles (Debus 2008; Olsen *et al*. 2013), such as aquatic snakes, freshwater turtles and lizards (both terrestrial and aquatic), including the 1.5-m water monitor *Varanus salvator* (Iqbal *et al*. 2013). This is the first report of predation on *C. porosus* by a White-bellied sea eagle.

Figure 3. White-bellied sea eagle in flight holding a small Saltwater crocodile. Photograph: Makrand M. Pardeshi.

Acknowledgements

I am very grateful to Mr. Makrand M. Pardeshi (Maharashtra), Mr. Rudrapratap Singh Rajawat (Whatsups App: 9783459569; 7014071463, Chambal Safari, Ranthambhore, Rajasthan) and Mr. Devendra Kumar Sharma (Kota, Rajasthan) for sharing their experiences and giving permission to use photographs.

Literature Cited

Choudhury, B.C. and Bustard, H.R. (1980). Predation on natural nests of the saltwater crocodile (*Crocodylus porosus*, Scheider) on North Andaman Island with notes on the crocodile population. Journal of the Bombay Natural History Society 76: 311-323.

Debus, S.J.S. (2008). Biology and diet of the White-bellied Sea-Eagle *Haliaeetus leucogaster* breeding in northern inland New South Wales. Australian Field Ornithology 25: 165-193.

Deraniyagala, P.E.P. (1939). The Tetrapod Reptiles of Ceylon. Volume I. Testudinates and Crocodilians. Colombo Museum: Ceylon.

Ferguson-Lees, J. and Christie, D.A. (2001). Raptors of the World. Houghton Mifflin Harcourt: New York.

Grimmett, R., Inskipp, C. and Inskipp, T. (2011). Birds of the Indian Subcontinent. 2nd edition. Oxford University Press and Christopher Helm: London.

Gramentz, D. (2008). Einige Bemerkungen zur Okologie und zum Verhalten von *Varanus salvator* (Laurenti, 1768) im Sudwesten von Sri Lanka. Sauria 30: 13-20.

Iqbal, M., Zockler, C. and Syroechkovskiy, E. (2013). White-bellied Sea-Eagle *Haliaeetus leucogaster* attempting to prey on Water Monitor *Varanus salvator*. Australian Field Ornithology 30: 206-209.

Jayewardene, J. (2004). Conservation and management of the two species of Sri Lankan crocodile (*Crocodylus porosus* and *Crocodylus palustris*). Pp. 154-165 *in* Crocodiles. Proceedings of the 17th Working Meeting of the IUCN-SSC Crocodile Specialist Group. IUCN: Gland, Switzerland.

Johnson, J.M. (1988). Purple Heron (*Ardea purpurea*) swallowing a Jungle Babbler. Journal of the Bombay Natural History Society 85(1): 190.

Kushlan, J.A. and Hancock, J.A. (2005). Herons. 1st Edition. Oxford University Press: Oxford.

Lang, J.W. (2002). Crocodilians. Pp. 212-221 *in* The New Encyclopaedia of Reptiles and Amphibians, ed. by T. Halliday and K. Adler. Oxford University Press: USA.

Table 1. Reported predators on wild Muggers (*Crocodylus palustris*) and Saltwater crocodiles (*C. porosus*). *= reported in Somaweera *et al*. (2013).

Group	Country	Reference
Mugger		
Reptiles		
Saltwater crocodile (*Crocodylus porosus*)	Sri Lanka	R. Whitaker, pers. obs.*
Bengal monitor (*Varanus bengalensis*)	India	Vyas (2010)
Water monitor (*Varanus salvator*)	Sri Lanka	Deraniyagala (1939); Whitaker and Whitaker (1979)
Monitor (*Varanus* sp.)	Iran	Mobaraki (2002)
Ganges soft-shell turtle (*Nilssonia gangeticus*)	India	R. Whitaker, pers obs.*
Birds		
Crow	Sri Lanka	Jayewardene (2004)
Pariah kite (*Milvus migrans govinda*)	India	B.C. Choudhury, pers. obs.*
Egrets	Sri Lanka	Jayewardene (2004)
Black-necked stork (*Ephippiorhynchus asiaticus*)	India	B.C. Choudhury, pers. obs.*
Unidentified herons and storks	Asia	Webb and Manolis (1989)
Painted stork (*Mycteria leucocephala*)	Sri Lanka	G. Rajapakse, pers. obs.*
Mammals		
Golden jackal (*Canis aureus*)	India, Sri Lanka	Webb and Manolis (1989); Vyas (2010); S. Karunarathne, pers. obs.*
Feral dog (*Canis lupus familiaris*)	India, Iran	Vyas (2010); Mobaraki, pers. obs.*
Asiatic lion (*Panthera leo persica*)	India	B. Pandya, pers. obs.*
Bengal tiger (*Panthera tigris*)	India	M.D. Parashar, pers. obs.*
Mongoose (*Herpestes* spp.)	India, Iran, Sri Lanka	Webb and Manolis (1989); Mobaraki (2002)
Striped-necked mongoose (*Herpestes vitticollis*)	Sri Lanka	S. Karunarathne, pers. obs.*
Wild/Feral pig (*Sus scrofa*)	Sri Lanka	R. Somaweera, pers. obs.*
Sloth bear (*Ursus ursinus*)	South Asia	Pooley and Ross (1989)
Saltwater Crocodile		
Insects		
Ants (*Iridomyrmex* spp.?)	Australia	G. Webb, pers. obs.*; C. Manolis, pers. obs.
Reptiles		
Aust. freshwater crocodile (*Crocodylus johnstoni*)	Australia	Webb and Manolis (1989)
Saltwater crocodile (*Crocodylus porosus*)	Australia	Messel and Vorlicek (1987); Webb and Manolis (1989)
Mangrove monitor (*Varanus indicus*)	Australia	Magnusson (1982)
Water monitor (*Varanus salvator*)	Sri Lanka	Deraniyagala (1939); Whitaker and Whitaker (1977); Gramentz (2008)
Monitor (*Varanus* sp.)	Australia, India	Messel and Vorlicek (1987); Choudhury and Bustard (1980)
Northern long-necked turtle (*Chelodina rugosa*)	Australia	Webb and Manolis (1989)
Birds		
Pariah kite (*Milvus migrans govinda*)	India	S. Kar, pers. obs.*
Mammals		
Small Indian mongoose (*Herpestes auropunctatus*)	India	S. Kar, pers. obs.*
Grey mongoose (*Herpestes edwardsi*)	India	S. Kar, pers. obs.*
Greater bandicoot rat (*Bandicota indica*)	India	S. Kar, pers. obs.*
Dusky rat (*Rattus colletti*)	Australia	Steel (1989)
Unidentified rodent/s	Australia	Messel and Vorlicek (1987); C. Manolis, pers. obs.
Wild/Feral pig (*Sus scrofa*)	India, Australia	Messel and Vorlicek (1987); Choudhury and Bustard (1980)

Magnusson, W.E. (1982). Mortality of eggs of the saltwater crocodile, *Crocodylus porosus*, in northern Australia. Journal of Herpetology 16: 121-130.

Magurran, A.E. and Seghers, B.H. (1990). Population differences in predator recognition and attack zone avoidance in the guppy, *Poecilia reticulata*. Animal Behavior 40: 443-452.

Martínez-Vilalta, A. and Motis, A. (1992). Family Ardeidae (Herons). Pp. 376-429 *in* Handbook of the Birds of the World. Ostrich to Ducks, Volume 1, ed. by J. del Hoyo, A. Elliott and J. Sargatal. Lynx Edicions: Barcelona.

Messel, H. and Vorlicek, G.C. (1987). A population model for *Crocodylus porosus* in the tidal waterways of northern Australia: Management implications. Pp. 189-198 *in* Wildlife Management: Crocodiles and Alligators, ed. by G.J.W. Webb, S.C. Manolis and P.J. Whitehead. Surrey Beatty and Sons: Chipping Norton.

Mobaraki, A. (2002). Snub-nosed crocodile, *Crocodylus palustris*, study in Iran. Pp. 253-256 *in* Crocodiles. Proceedings of the 16th Working Meeting of the IUCN-SSC Crocodile Specialist Group. IUCN: Gland, Switzerland.

Olsen, J., Debus, S.J.S., Rose, A.B. and Judge, D. (2013). Diets of White-bellied Sea-Eagles *Haliaeetus leucogaster* and Whistling Kites *Haliastur sphenurus* breeding near Canberra, 2003-2008. Corella 37(1): 13-18.

Pooley, A.C. and Ross, C. (1989). Mortality and predators. Pp. 92-101 *in* Crocodiles and Alligators. Facts on File, ed. by C.A. Ross and S. Garnett. Facts on File Inc.: USA.

Somaweera, R., Brien, M. and Shine, R. (2013). The role of predation in shaping crocodilian natural history. Herpetological Monographs 27: 23-51.

Steel, R. (1989). Crocodiles. Christopher Helm: UK.

Vyas, R. (2010). The Muggers, *Crocodylus palustris* of Vishwamitri River: Past and Present. Herpetology and Environmental Research Project: India.

Webb, G. and Manolis, S.C. (1989). Crocodiles of Australia. Reed Books: Australia.

Whitaker, R., and Whitaker, Z. (1977). Notes on vocalization and protective behavior in the mugger. Journal of the Bombay Natural History Society 75: 227-228.

Whitaker, R. and Whitaker, Z. (1979). Preliminary crocodile survey - Sri Lanka. Journal of the Bombay Natural History Society 76: 66-85.

Raju V. Vyas, *1 - Sashwat Apartment, Anand Nager, BPC Haveli Road, Nr. Splatter Studio, Alakapuri, Vadodara 390007, Gujarat, India (razoovyas@hotmail.com).*

GHARIAL IN THE YAMUNA RIVER UPSTREAM OF THE CHAMBAL CONFLUENCE. Historically, the Gharial (*Gavialis gangeticus*) occurred in the Yamuna River throughout its course, with multiple records from the 1800s around populated centers such as Delhi and Agra (Lang *et al*. 2019). Presently, the largest population of wild, free-living Gharial occurs in the lower 425+ km of the Chambal River which confluences with the Yamuna downstream of Etawah, a regional center situated on the Yamuna, approximately 80 km above the Yamuna-Chambal confluence. The Chambal population is estimated at 1600-2000 individuals, with >400 nests annually in recent years (GEP Field Report, 2018).

Within the past decade, there have been sporadic reports of Gharial sightings in this 80-km stretch of the Yamuna, including at least one instance of a female nesting 12 km above its confluence with the Chambal (Chauhan 2011). Here, we document a recent (2019) nesting, with successful hatching, on the Yamuna at Etawah, and briefly review the available information on Gharial in the lower Yamuna below Etawah.

On 18 June 2019, a Gharial nest was observed near Yamuna Ghat, on the edge of the city of Etawah (Fig. 1). Twenty-one hatchlings were present at the base of the nest, with a guardian female nearby. Subsequent visits to the nest site indicated the presence of hatchlings and the female in the vicinity for about a week, at which point there were local news releases about the nest with hatchlings that included its exact location. On 28 June, following these press releases, the female was no longer observed at the site and there were fewer hatchlings evident, and on 2 July only 5-6 hatchlings were counted and there was no evidence of the female. By this date, the site had become a local tourist attraction, with throngs of visitors frequenting the nesting bank. On a recent visit by the observer team, a fish eagle (*Haliaeetus leucoryphus*) was seen hovering near the small, unattended group of hatchlings.

This nest site was near the top of a long sand bank on the east side of the Yamuna main channel, close to a deep pool just downstream of the nest site (Fig. 2). On the sandbank, locals engage in river side agriculture as well as fishing. The sewage outflow from the city of Etawah drains into the main Yamuna channel from a nearby nullah, and a public crematorium is located just downstream of the sandbank on which the nest is located, visible in the background looking downstream from the nest site. The site is easily accessible during the pre-monsoon low water conditions, and adjacent to several major thoroughfares for vehicles, and ready access to Yamuna Ghat by public conveyance.

Previously, on 2 June 2011, a Gharial nest reportedly hatched downstream on the Yamuna (Chauhan 2011). At that time, an observer from the Gharial Ecology Project made two subsequent visits nest site. The nest was situated on the east bank of the Yamuna, on a long high sandbank similar to the one described above (Fig. 3). This area was relatively undisturbed agricultural land, with infrequent riverside visitors, primarily herders and farmers. On 12 June 2011, 10 days post-hatch, a female was observed with 45 hatchlings at

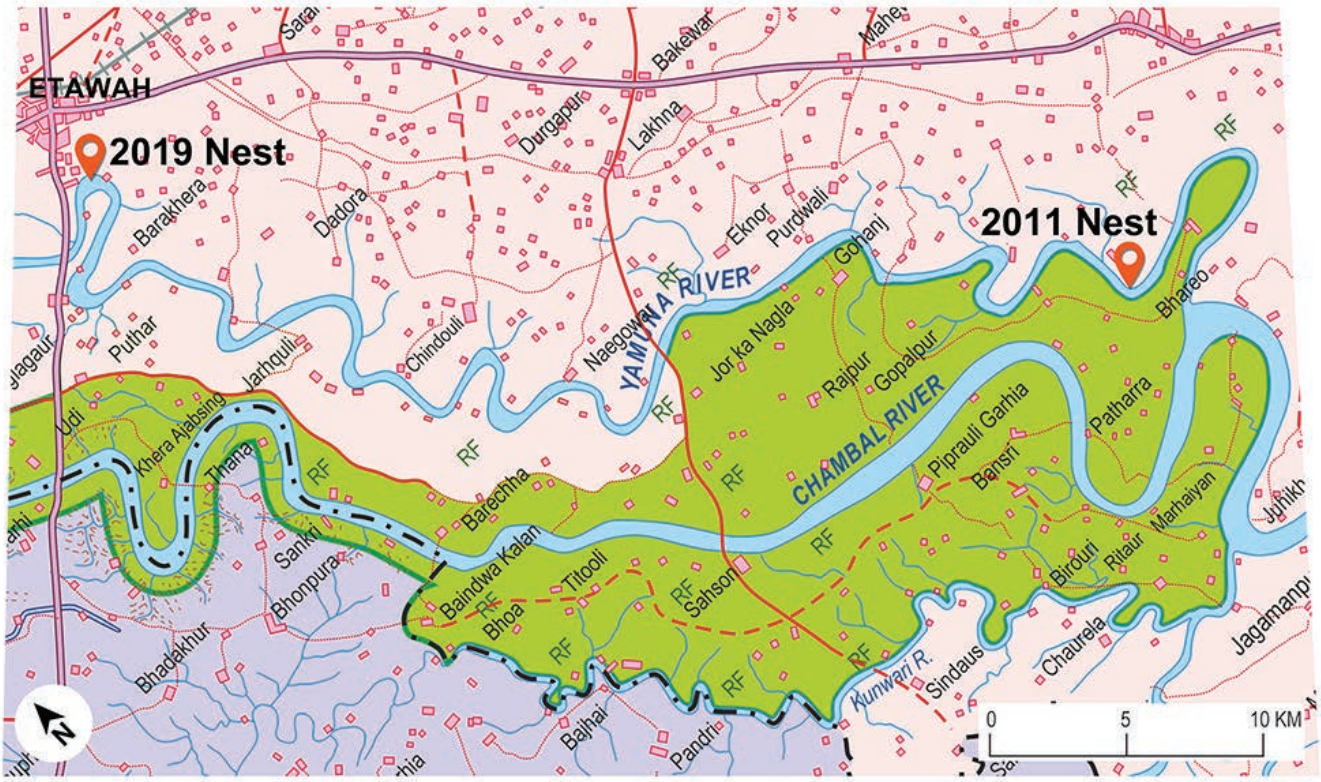


Figure 1. Locations of 2019 nest site near city of Etawah at Yamuna Ghat (upper left), 80 km upstream on the Yamuna River from its confluence with the Chambaland, and 2011 nest site reported by Chauhan (2011) at 12 km upstream from the Yamuna-Chambal confluence (upper right).

Figure 2. View looking downstream of east bank of Yamuna main channel (adjacent to Yamuna Ghat, and within view of public crematorium, visible in distance), and showing location of 2019 nest site, with crop fencing visible in center left, and domestic buffalo near nest at shoreline.

the base of the nest. On 28 June 2011, the Yamuna was in full flood, with high water on the sandbank at the level of the nest; no Gharial were observed nearby.

In his account, Chauhan (2011) notes that the volunteer observer noted mouth transport of neonates by the female from the nest into the water on several occasions. On the basis of more than a decade of intensive nest monitoring at multiple colonial nest sites, we question this assertion. Our data clearly indicate that Gharial hatchlings, without exception, walk to water from the excavated nest, opened by the female, which shows no inclination to manipulate either the eggs or

Figure 3. View of 2011 nest site, located on east sandbank of Yamuna (flowing downstream right to left), with nest site noted (red legend), and female with hatchlings at shoreline, image taken 10 days post-hatch, 12 June 2011. 45 hatchlings were counted at this site on that date. Observation on 28 June noted the Yamuna in full flood, with no hatchlings or adults evident, and the nest site nearly inundated by high water.

hatchlings with her snout. Multiple hatchling tracks from nest to water are evident at all of these nests. This behaviour, unparalleled amongst other living crocodilians, distinguishes Gharials from most species that routinely engage in mouth transport of hatchlings, primarily in conveyance from the nest to the water nearby at hatching.

Our recent report of Gharial successfully nesting at a location 80 km from the Yamuna-Chambal confluence, well upstream, at 40 km above the upper boundary of the National Chambal

Sanctuary, suggests that there is likely a small resident breeding population of Gharial in the lower Yamuna below Etawah. In our judgement, it is unlikely that a female would move more than 100 km down the Chambal, from the nearest known breeding area on the Chambal, then up the Yamuna to nest, at a long distance from where she bred a month earlier. We suggest that differing water level regimes on the Yamuna versus Chambal may involve local adaptation for females nesting in the Yamuna. Specifically, this may entail anticipating earlier and higher flooding during the annual monsoon immediately following hatching, with consequent nesting earlier and at higher sites on the Yamuna, relative to the nesting pattern on the Chambal.

Observations of large ghara males, capable of breeding, in the lower Yamuna are rare, but are documented. Locals at the 2019 site reported a large male being seen two weeks prior to hatching in the nest vicinity. Other sightings of large males in the lower Yamuna, as well as other adult Gharial have been documented by the Gharial Ecology Project team in the course of routine observations over the past decade. Several telemetered juveniles have resided during the dry season at 20+ km upstream of the Chambal confluence within the National Chambal Sanctuary stretch of the Yamuna, and in subsequent years, returned to their capture sites located on the lower Chambal.

It is important to note that river flows of both the Yamuna and Chambal are strongly influenced by monsoon flooding which is not necessarily synchronous in both rivers. When the Yamuna is in flood, while the Chambal is not, water flows backward from the rising Yamuna as far as 15-30 km upstream in the Chambal. A similar scenario plays out on the Yamuna, when the Chambal is in full flood (and the Yamuna is not), with backward flow up the Yamuna, at least 10-15 km because the low ground along the Yamuna is more extensive than on the Chambal. Fish, and other aquatic species such as dolphins, turtles and crocodilians, are passively transported upstream when backflow occurs, and then are concentrated at the turbulent confluence boundary where the two rivers meet. Feeding on fish at the confluence boundary is most evident when the backward flow is reversed, bringing with it, especially concentrated groupings of fish. The dynamic and variable water flows in these open river systems is a likely contributor to the seasonal movements of Gharial and other fauna between the lower Chambal and Yamuna.

Chitra Ecology Project team members, AshutoshTripathi and Anand Kumar, made the initial observations documenting the 2019 nesting near Etawah. Pankaj Kumar of the Gharial Ecology Project made observations in the lower Yamuna, including the 2011 nest, during the past decade of intensive work, observing and tracking Gharial.

We thank the Uttar Pradesh Forest Department for the necessary permissions to carry out these studies, and for numerous courtesies extended to our field teams in recent years. Local residents Sanu Parvesh and Sudeep at the 2019 site conducted frequent observations of the nest and hatchlings in between our field visits.

Literature Cited

Chauhan, R. (2011). First record of Gharial nest hatching in Yamuna River, Uttar Pradesh, India. Crocodile Specialist Group Newsletter 30(3): 14-15.

Gharial Ecology Project (2018). Field Report on Chambal Populations & Nests (2017-18). Unpublished report. https://www.academia.edu/37054538/GEP_Field_Rpt_Pop_Nests_2018.

Lang, J.W., Chowfin, S. and Ross, J.P. (2019). *Gavialis gangeticus*. The IUCN Red List of Threatened Species 2019:e.T8966A3148543. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T8966A3148543.en

Ashutosh Tripathi, Anand Kumar, Pankaj Kumar and Jeffrey W. Lang, *Chitra Ecology Project and Gharial Ecology Project, Madras Crocodile Bank Trust, ECR Road, Vadanammelli Village, Mahabalipuram 603104 Tamil Nadu, India*.

North America

USA

CLEMSON BARUCH INSTITUTE HOSTS 3RD PALMETTO ALLIGATOR RESEARCH AND MANAGEMENT SYMPOSIUM. The 3rd Palmetto Alligator Research and Management Symposium was held at the Clemson University Baruch Institute of Coastal Ecology and Forest Science in Georgetown, South Carolina, on 19 April 2019. Sixteen speakers, including 8 CSG members, from five states and three countries gave presentations on a diversity of topics related to crocodilian biology and management (Fig. 1). Over 75 people, representing state and federal agencies, municipalities, private landowners, universities, animal parks, zoos and aquaria, and NGOs attended the symposium. CSG members Ab Abercrombie, Sam Seashole and Phil Wilkinson were also in attendance.

Figure 1. Speakers at the symposium. Front row (L to R): Matthew Hale, Josh Zajdel, Anje Kidd-Weaver, Alicia Davis, Bailey Alston, Adam Rosenblatt, Samantha Bock, Vinnie Deem. Back row (L to R): Gil Grant, Thomas Rainwater, Abby Lawson, Russ Lowers, Jon Warner, Arnold Brunell, Hannes Botha, Jeff Lang. Photograph: Ben Parrott.

The early portion of the program focused on alligator management and associated issues across the species' range, particularly North Carolina, Florida and Texas. This was followed by multiple presentations on alligator mating dynamics, movement patterns, behavior, immunology, ecotoxicology, and the influence of climate change on hatchling sex ratios. In addition, Jeff Lang provided a detailed update on the Gharial Research Project in northern India, Hannes Botha shared new data related to previous Nile crocodile mass mortalities on the upper Olifants River in South Africa, and Arnold Brunell described recent studies on movement and survivorship of translocated American crocodiles in south Florida. A student poster session was held during lunch, allowing for interactions in a more personal setting and relaxed atmosphere.

Figure 2. CSG members Phil Wilkinson (left) and Jeff Lang (right) at the Tom Yawkey Wildlife Center, April 2019. Photograph: Thomas Rainwater.

After weathering a violent thunder storm that rocked the meeting venue, the symposium was followed by a dinner/social where speakers and attendees were treated to Phil Wilkinson's Santee Delta Perlou (seasoned chicken, sausage, onions and rice), Lowcountry green beans and "UT's" homemade coleslaw. Conversations about crocodilian research, management, and conservation continued late into the night. The following day, some of the remaining attendees visited the nearby Tom Yawkey Wildlife Center (Fig. 2), site of long-term alligator research since the 1970s. The next (4th) symposium is scheduled for spring 2021.

Thomas R. Rainwater, *Tom Yawkey Wildlife Center & Baruch Institute of Coastal Ecology and Forest Science, Clemson University, Highway 17 North, P.O. Box 596, Georgetown, SC 29440-0596, USA; trrainwater@gmail.com*.

FIRST SEAFWA ALLIGATOR WORKING GROUP MEETING IS HELD AT ROCKEFELLER WILDLIFE REFUGE, LOUISIANA. The recently formed Alligator Working Group (AWG) (Elsey and Linscombe 2018) held its first meeting outside of the annual meeting of the Southeastern Association of Fish and Wildlife Agencies (SEAFWA). The AWG meeting was held on 24 April 2019, at the Louisiana Department of Wildlife and Fisheries' Rockefeller Wildlife Refuge (RWR) in Grand Chenier.

Meeting participants and states represented included Chris Nix (Alabama), Mark Barbee (Arkansas), Greg Balcom (Georgia), Amity Bass, Jeb Linscombe, Ruth Elsey, Jason Waller and Angela Guidry (Louisiana), Ricky Flynt (Mississippi), Alicia Davis (North Carolina), Morgan Hart (South Carolina) and Jon Warner (Texas).

Participants gathered for breakfast and briefly discussed the day's itinerary, and then departed for an airboat tour of the Superior Marsh impoundment to discuss habitat management strategies in coastal Louisiana and to conduct a release of young alligators hatched from eggs incubated at RWR. Topics discussed included the appropriate type of marsh habitat selected for the yearling release (small ponds with abundant prey; Fig. 1) versus less suitable areas (adult habitat consisting of deep water canals and lakes) that were observed during the tour, and marsh management practices employed at the refuge and their impacts on alligator productivity.

Figure 1. During a field trip including an airboat tour, Jeb Linscombe (LDWF Alligator Program Manager) discussed appropriate habitat selection in coastal marshes for release of juvenile alligators to enhance survival.

After the field trip, participants returned to the meeting location for presentations and a working lunch. Jeb Linscombe's presentation covered population monitoring in Louisiana including helicopter nest survey transects in Louisiana, quota establishment outside of Louisiana's coastal zone, assistance from Law Enforcement with implementation of alligator management regulations, legal hunting hours and minimum harvest sizes in Louisiana versus other range states, adaptive strategies used in establishing egg harvest quotas, current and forecasted egg prices, discussion of various types of alligator and alligator egg transfers between industry participants, and discussion of Louisiana's farm "returns to the wild" and how this requirement is currently viewed by industry members and landowners.

Jason Waller's presentation (Fig. 2) reviewed population monitoring in Florida, including necessary equipment and expenses for conducting spotlight surveys, size categories used to classify alligators observed, methods to standardize survey efforts to reduce variability, possible impacts to survey data and biological consequences of hunters targeting the largest size-class alligators, pros and cons of using spotlight survey data in place of aerial nest surveys to establish egg harvest quotas, the benefits of a population model that analyzes a long-term trend with regards to managing hunts and establishing quotas with a fair level of consistency, and the objective of keeping alligator populations stable on management units in Florida relative to pre-harvest levels.

Figure 2. LDWF's Biologist Manager Jason Waller gave a detailed presentation on spotlight surveys, harvest quotas, and management strategies used in Florida.

Ruth Elsey then provided an update on Louisiana's management and research programs. An outline of the main programs the alligator section staff handle was discussed, including the wild harvest program, farming and ranching program, nuisance alligator management, and research. An overview of historic research showed how telemetry and field biology studies led to the current wild harvest management program, and how early nesting ecology and culture research led to the development of the current farming and ranching programs. Highlights of some past studies were briefly covered, including use of drones to detect alligator nests, effects of feral hogs on nesting habitat and alligator nest losses, incidence of alligator nests on terraces constructed for marsh restoration, research on invasive apple snails and alligator feeding ecology, dispersal and movement of wild alligators, and other projects. Current ongoing studies with numerous collaborators were outlined, as were future research objectives.

A group discussion was led by Jeb Linscombe regarding a proposal to use similarly styled and printed CITES tags for alligators harvested in the southeastern states. Members of the group provided insight about feedback of support and/or opposition they have received in their state about this topic. Members were asked to seek further direction from their agencies and report their findings back to the AWG.

An update on disease monitoring in Louisiana was led by Amity Bass, including the current status of the resolution to require veterinary certification before alligators can be transferred in or out of Louisiana. Communications with SEAFWA are ongoing as to whether or not this should be a mandate for all range states and whether or not additional supporting data is needed since this is intended to be a proactive measure. In addition, updates were provided on disease monitoring and sampling methods being conducted and developed by Dr. Javier Nevarez (Louisiana State University School of Veterinary Medicine) to monitor for any occurrence of *Chlamydia* and *Mycoplasma* in wild and captive alligators.

Other business items discussed included: follow-up discussion on timelines for implementing the uniform tagging proposal discussed earlier, discussion on CITES tag orders including whether or not to order a surplus and the process for disposing of unused tags, and guests were provided with a status update on the new laboratory being constructed at RWR. After the meeting was concluded, guests who needed to break away for travel were able to depart. Those who were lodging at the refuge were able to take a tour of the laboratory facility and some also toured the historic alligator holding tanks and observed a leucistic alligator and several alligators exhibiting polydactylism (Fig. 3).

Figure 3. Participants toured holding tanks at Rockefeller Wildlife Refuge to view a leucistic alligator and juveniles with polydactylism.

At the evening meal, we had more opportunity for socializing and exchange of ideas and solutions for common issues in alligator management programs. The next meeting of the AWG will be held at annual SEAFWA conference (27-30 October 2019) in Hilton Head, South Carolina.

Literature Cited

Elsey, R. and Linscombe, J. (2018). Alligator Working Group

established. Crocodile Specialist Group Newsletter 37(4): 4-5.

Ruth Elsey *(relsey@wlf.la.gov),* Jason Waller *(jwaller@wlf.la.gov)* and Jeb Linscombe *(jlinscombe@wlf.la.gov), Louisiana Department of Wildlife and Fisheries, Louisiana, USA.*

$30K FOR AMERICAN CROCODILES IN FIVE COUNTRIES! Summer CrocFest 2019 took place on 8 June 2019 at Zoo Miami, in Miami, Florida, and attracted nearly 400 attendees and raising over $US30,000 for crocodile conservation! Funds raised will support research and conservation projects for the American crocodile (*Crocodylus acutus*) in the USA, Belize, Guatemala, Colombia and Costa Rica. All of the projects aim to preserve in-country *C. acutus*, and propose various means by which to minimize or avoid human-crocodile conflict. The projects being supported are:

1. Using a Threatened Species to Monitor an Endangered Ecosystem: The American Crocodile (*Crocodylus acutus*) in the Florida Everglades. The Croc Docs, USA.

2. Crocodile Conservation and Community Stewardship in Belize. Marisa Tellez, Crocodile Research Coalition, Belize.

3. Update on the Status of the Populations of *Crocodylus acutus* in two Guatemalan Protected Areas of the Pacific and Atlantic Slopes. Valerie Corado Garcia and Jose Octavio Cajas, Guatemala.

4. Spatial Ecology of the American Crocodile in a Highly-visited Protected Area in the Colombia Caribbean. Sergio Balaguera-Reina, Colombia.

5. Pollution by Dispersal: Transport Mechanisms for Endocrine Disrupting Contaminants in Vanishing Wetlands. Mahmood Sasa Marin, Christopher Murray and Mark Merchant, Costa Rica.

Figure 1. Joe Wasilewski addresses participants before the auction.

Figure 2. The CrocFest Core and friends.

CrocFest fundraisers are family-friendly events geared to increase awareness of and raise money for international crocodile conservation. Event-goers were granted access to the full grounds of Zoo Miami and were treated to specialized behind-the-scenes tours led by enthusiastic Zoo Miami staff. Despite the arrival of severe thunderstorms that lasted for several hours, CrocFesters remained clustered undercover to enjoy swap stories, enjoy beeach other's company, join together for a fantastic meal prepared by Nick Wasilewski and support the cause via a rousing live auction conducted by Joe Wasilewski and Curt Harbsmeier.

Thanks to the generosity and commitment of the private sector, zoos, and corporate sponsors all working together, as of June 2019, CrocFest fundraisers have generated over $US417,000 for crocodilians in peril! All proceeds go directly to crocodilian projects, with event expenses covered by event organizers and sponsors.

It is anticipated that the proceeds of the upcoming Winter CrocFest, to be held on 7 December 2019 at St. Augustine Alligator Farm, St. Augustine, Florida, will also be dedicated to these projects.

Event organizers: Curt Harbsmeier *(Executive Board Member, Tampa's Lowry Park Zoo),* Flavio Morrissiey *(Operations Director, You Name It Tours)* and Colette Adams *(Deputy Director, Gladys Porter Zoo).*

Submitted Publications

OBSERVATIONS OF LARGE NILE CROCODILES (*CROCODYLUS NILOTICUS*). The Nile crocodile (*Crocodylus niloticus* Laurenti 1768) is generally regarded as one of the largest extant crocodilians. However there is a dearth of reliable records for the largest specimens. The total length (TL) of 6.10 m is commonly cited in the literature as the largest

recorded size of *C. niloticus*, but this has yet to be authenticated.

Skulls in museums and private collections are often the only evidence of large specimens, but the TLs of their former owners are usually not recorded. Size estimation is possible using morphometric relationships between length and head/skull length [= dorsal cranial length (DCL); eg Hutton 1987; Wermuth 1964], but the largest animals are typically outside the size ranges for which equations have been derived, and so there may be significant errors around those size estimates (Britton *et al*. 2012). It appears that DCL becomes a smaller proportion of TL with increasing size. The DCL:TL ratio for a "typical crocodilian" has been established as 1:7 (Webb and Manolis 1989), but this relationship may not apply to the very largest crocodilians (Fukuda *et al*. 2013).

I present observations of large *C. niloticus* made by trained scientists, provide an observed DCL:TL ratio for large specimens of *C. niloticus*, and analyse the applicability of the 1:7 ratio for the species.

Largest *C. niloticus* ever recorded

The largest *C. niloticus* ever recorded was a specimen approximately 5.80 m TL (Cott 1961), which would have an estimated weight of 1082 kg (Hutton 1987).

Largest crocodile ever captured and released alive

Brady Barr embarked on an expedition around the world in 2007 to verify whether ≥5.50 m TL crocodiles existed in the wild. The findings of this expedition were not published, but were presented in a program (Dangerous Encounters: Size Matters) broadcasted on the National Geographic Channel. In Katavi National Park in Tanzania, Brady Barr captured a 5.36 m long *C. niloticus*. As it was missing a considerable portion of its tail tip, TL is underestimated. Nonetheless, DCL was 66.0 cm, and therefore DCL:TL ratio was calculated 1:8.1. This specimen's weight is estimated as 838 kg using the equations of Hutton (1987). According to Brady Barr, this is the largest crocodile ever captured and released alive.

Largest known *C. niloticus* skulls

The largest known *C. niloticus* skull (68.6 cm DCL) is housed at Arba Minch Crocodile Ranch, near Lake Chamo in southern Ethiopia (Whitaker and Whitaker 2008). If a DCL:TL ratio of 1:8.1 (see above) is applied to this skull, TL is estimated at 5.56 m. A slightly smaller skull (67.9 cm DCL; also at Arba Minch Crocodile Ranch) would be around 5.50 m on the same basis.

Largest *C. niloticus* in captivity

I believe the largest *C. niloticus* in captivity is housed at Mamba Village Centre, Mombasa, Kenya. This male specimen, named "Big Daddy", was captured from the Tana River, Kenya, in 1986, after reportedly having eaten 5 people. Big Daddy weighs 800 kg, measures 5.0 m TL, and is currently estimated to be 113 years old. When placed in a pond with other crocodiles at Mamba Village Centre, Big Daddy killed 10 of them, and crocodiles that survived the attacks were left with broken jaws, tail amputations, etc. Big Daddy was then put in another pond, with two females, named "Sasha" and "Salma".

Largest crocodile in captivity

Weighing in at approximately 1300 kg and measuring 5.48 m in TL, "Cassius" is as tough as they come. This Saltwater crocodile (*C. porosus*) was captured in the Finniss River in the Northern Territory of Australia in 1984, and relocated in 1987 to his current home at Marineland Melanesia on Green Island, Queensland, Australia, by George Craig. He is missing approximately 15 cm off the end of his tail, is missing his front left leg, and carries many battle scars - a testament to a hard-fought life like his namesake heavyweight boxing champion Cassius Clay (aka Muhammad Ali).

Discussion

The largest *C. niloticus* ever recorded (Cott 1961) is an example of what Brady Barr explained in his program. That most records of ≥5.50 m TL wild crocodiles pre-date the 1970s, before extensive and widespread hunting decimated populations and removed most of the very large specimens, this is possibly why very large wild crocodiles are rarely recorded in modern times.

The largest crocodile ever captured and released alive by Brady Barr, serves as an example that there could still be very large crocodiles in the wild. As this specimen's morphometric measurements were not published, it is also an example that there are possibly many very large wild crocodiles that have been measured by trained scientists that we may not know about.

If a DCL:TL ratio of 1:7 is applied to the largest crocodile ever captured and released alive, TL is estimated at 4.62 m, which reflects an underestimate of 14%. This significant estimation error is a clear indication of the inapplicability of the 1:7 ratio for large *C. niloticus*.

Acknowledgements

I thank Brady Barr for verifying with me his unpublished work. Charlie Manolis provided helpful comments on each draft of the manuscript. Charlie Manolis and Grahame Webb kindly reviewed the manuscript.

Literature Cited

Britton, A.R.C., Whitaker, R. and Whitaker, N. (2012). Here be a dragon: Exceptional size in a Saltwater crocodile (*Crocodylus porosus*) from the Philippines. Herpetological Review 43(4): 541-546.

Cott, H.B. (1961). Scientific results of an inquiry into the ecology and economic status of the Nile Crocodile (*Crocodylus niloticus*) in Uganda and northern Rhodesia. Transactions of the Zoological Society of London 29(4): 211-356.

Fukuda, Y., Saalfeld, K., Lindner, G. and Nichols, T. (2013). Estimation of total length from head length of saltwater crocodiles (*Crocodylus porosus*) in the Northern Territory, Australia. Journal of Herpetology 47: 34-40.

Hutton, J.M. (1987). Morphometrics and field estimation of the size of the Nile crocodile. African Journal of Ecology 25(4): 225-230.

Laurenti, J.N. (1768). Specimen medicum, exhibens synopsin reptilium emendatam cum experimentis circa venena et antidote reptilium austracorum, quod authoritate et consensu. Vienna, Joan. Thomae.

Webb, G.J.W. and Manolis, S.C. (1989). Crocodiles of Australia. Reed: Sydney, Australia.

Wermuth, H. (1964). Das Verhaltnis zwischen Kopf-, Rumpf- und Schwanzlange bei den rezenten Krokodilen. Senckenbergiana 45: 369-385.

Whitaker, R. and Whitaker, N. (2008). Who's got the biggest? Crocodile Specialist Group Newsletter 27(4): 26-30.

[Editor's note: Georges lives in Mwanza, Tanzania. With crocodiles as his "favourite" animal since a child, he set about drafting a short paper on crocodiles whilst still at school - out of interest rather than as part of the school curriculum. The CSG encourages young people to follow their passion with crocodiles, and encouraged Georges to submit his article for the CSG Newsletter].

Georges Ndikumana, *The American Business School of Paris, France (gndikumana@hotmail.co.uk)*.

Recent Publications

Schneider, C.S. (2019). Alligator (*Alligator mississippiensis*) Taphonomy Analysis of Gnawed and Digested Bone. MSc thesis, Boston University School of Medicine, Boston, USA.

Abstract: Understanding the tooth mark morphology and behavior of animal scavenging is essential in forensic analysis during recovery of remains in an outdoor setting. Scavengers are part of the natural process of disarticulation; therefore, further research on these taphonomic agents can aid in the analysis of various postmortem bone modifications. The present study focuses on the classifiable morphologies of American alligator (*Alligator mississippiensis*) bite marks on bone as a method of clearly distinguishing bite marks from other scavengers, specifically canids. Based on previous research, the bite marks of American alligators include punctures, pits, and scoring; however, American alligators also have potentially diagnostic bite marks including bisected mark and hook scores. The sample for the present study consisted of feeding 5 adult American alligators, aged at least 50 years old, and four 9-year-old American alligators located at the Edisto Island Serpentarium in Edisto Island, South Carolina. The bones fed to the alligators included: 33 commercially available white-tailed deer (*Odocoileus virginianus*) partially fleshed long bones, which included articulated radii and ulnae, femora, tibiae, and humeri; 15 pounds of partially fleshed white-tailed deer back ribs; and 25 pounds of mostly fleshed white-tailed deer neck bones. Additionally, 6 articulated pig (*Sus scrofa*) fully fleshed hind limbs were included in the present study. The alligators were typically fed three days a week during the duration of the study. Once the bones were gnawed on by the alligators and left alone in their enclosures, the bones were collected by the serpentarium personnel and stored for analysis. After bones were macerated, the author observed and measured the morphologies of the tooth marks on the bone surface and observed each tooth mark. There was a total of 412 tooth marks observed on all bones. The most frequent tooth mark observed on all bones were pits, followed by punctures, scores, furrows, hook scores, and bisected marks. The results indicate that American alligators have the potential to leave identifiable marks; however, crocodylian species also leave some tooth marks that are morphologically indistinguishable from other mammalian carnivores. The patterns of tooth marks were distinguished from other mammalian carnivores based upon previously published literature, such as Njau and Blumenschine (2006), Drumheller *et al*. (2014), Delaney-Rivera *et al*. (2009), Dominguez-Rodrigo and Piqueras (2003), and Pobiner (2007). A paired t-test was run to statistically compare the frequencies of tooth marks from previous crocodylian studies and descriptive statistics are provided to analyze the tooth mark measurements. The present research demonstrates the potential of tooth marks to identify the activity of American alligators.

Ballell, A., Moon, B.C., Porro, L.B., Benton, M.J. and Rayfield, E.J. (2019). Convergence and functional evolution of longirostry in crocodylomorphs. Palaeontology 2019: 1-21.

Abstract: During the Mesozoic, Crocodylomorpha had a much higher taxonomic and morphological diversity than today. Members of one particularly successful clade, Thalattosuchia, are well-known for being longirostrine: having long, slender snouts. It has generally been assumed that Thalattosuchia owed their success in part to the evolution of longirostry, leading to a feeding ecology similar to that of the living Indian gharial, *Gavialis*. Here, we compare form and function of the skulls of the thalattosuchian *Pelagosaurus* and *Gavialis* using digital reconstructions of the skull musculoskeletal anatomy and finite element models to show that they had different jaw muscle arrangements and biomechanical behaviour. Additionally, the relevance of feeding-related mandibular traits linked to longirostry in the radiation of crocodylomorph clades was investigated by conducting an evolutionary rates analysis under the variable rates model. We find that, even though *Pelagosaurus* and *Gavialis* share similar patterns of stress distribution in their skulls, the former had lower mechanical resistance. This suggests that compared to *Gavialis*, *Pelagosaurus* was unable to process large, mechanically less tractable prey, instead operating as a specialized piscivore that fed on softer and smaller prey. Secondly, innovation of feeding strategies was achieved by rate acceleration of functional characters of the mandible, a key mechanism for the diversification of certain clades like thalattosuchians and eusuchians. Different rates of functional evolution suggest divergent diversification dynamics between teleosaurids and metriorhynchids in the Jurassic.

Brownstein, C.D. (2019). First record of a small juvenile giant crocodyliform and its ontogenetic and biogeographic implications. Bulletin of the Peabody Museum of Natural History 60(1): 81-90.

Abstract: *Deinosuchus* is a genus of large crocodylian that inhabited North America during the Late Cretaceous. This massive predator has become one of the most well-known prehistoric organisms, with a considerable amount of literature on its biogeography, ecology, and evolution published. However, ontogenetic changes of *Deinosuchus* and other species of extinct large, predatory crocodyliforms have remained poorly understood because of a lack of remains known from juvenile individuals and issues surrounding the ability of histological analysis of adult material to provide information on yearly growth. Here, I describe a tooth from a juvenile *Deinosuchus* estimated at less than 1 m in total body length. As the first reported specimen of a juvenile *Deinosuchus*, to the author's knowledge, in the literature, the new fossil evinces the extremely small size of young individuals of this taxon compared to adults more than 8 m and 3500 kg. Furthermore, the tooth shows that some morphological discrepancies existed between the dentition of juvenile and adult *Deinosuchus* individuals, including the size of the nutritive region. In addition to being the first specimen of *Deinosuchus* from northeastern North America described in detail, the tooth emphasizes the biological extremes of attaining large body size in *Deinosuchus* and may add support to the hypothesis that the ontogeny of gigantic crocodyliforms was characterized by extended periods of juvenile growth.

Woodyard, E.T., Baumgartner, W.A., Rosser, T.G., Bodin, E.N., Ferrara, A.M., Noto, T.W., Ford, L.M. and Rush, S.A. (2019). Morphological, molecular, and histopathological data for *Sebekia mississippiensis* Overstreet, Self, and Vliet, 1985 (Pentastomida: Sebekidae) in the American alligator, *Alligator mississippiensis* Daudin, and the Spotted Gar, *Lepisosteus oculatus* Winchell. Journal of Parasitology 105(2): 283-298.

Abstract: Novel molecular data from both mitochondrial (cytochrome c oxidase subunit 1) and ribosomal regions (18S, ITS1-5.8S, ITS2, and 28S) are provided for *Sebekia mississippiensis* Overstreet, Self, & Vliet, 1985, a pentastome infecting the American alligator, *Alligator mississippiensis* Daudin, 1801, and the spotted gar, *Lepisosteus oculatus* Winchell, 1864. Adult and nymphal pentastomes are described from the lungs and liver of the type host, *A. mississippiensis*, collected from Mississippi, while additional nymphs are described from the esophageal lining of *L. oculatus* specimens collected from Louisiana. This sequencing data will facilitate more accurate identification of various life cycle stages of *S. mississippiensis*, enabling future work to resolve many ambiguities in the literature regarding this species. Additionally, histopathological data are provided from both the definitive and intermediate hosts.

Akbar, N., Siddiqui, R., Sagathevan, K.A. and Khan, N.A. (2019). Gut bacteria of animals/pests living in polluted environments are a potential source of antibacterials. Applied Microbiology and Biotechnology (https://doi.org/10.1007/s00253-019-09783-2).

Abstract: The morbidity and mortality associated with bacterial infections have remained significant despite chemotherapeutic

advances. With the emergence of drug-resistant bacterial strains, the situation has become a serious threat to the public health. Thus, there is an urgent need to identify novel antibacterials. The majority of antibiotics available in the market are produced by bacteria isolated from soil. However, the low-hanging fruit has been picked; hence, there is a need to mine bacteria from unusual sources. With this in mind, it is important to note that animals and pests such as cockroaches, snake, crocodiles, and water monitor lizard come across pathogenic bacteria regularly, yet flourish in contaminated environments. These species must have developed methods to defend themselves to counter pathogens. Although the immune system is known to possess antiinfective properties, gut bacteria of animals/pests may also offer a potential source of novel antibacterial agents, and it is the subject of this study. This paper discusses our current knowledge of bacteria isolated from land and marine animals with antibacterial properties and to propose untapped sources for the isolation of bacteria to mine potentially novel antibiotic molecules.

Ahmad Nizar, N.N., Hossain, M., Sultana, S., Ahamad, M.N., Johan M.R. and Ali, M.E. (2019). Quantitative duplex real-time polymerase chain reaction assay with TaqMan probe detects and quantifies *Crocodylus porosus* in food chain and traditional medicines. Food Additives & Contaminants. Part A. Chemistry, Analysis, Control, Exposure & Risk Assessment 4: 1-11.

Abstract: Consumption and exploitation of crocodiles have been rampant for their exotic, nutritive and medicinal attributes. These depredations are alarming and although they have continued to be monitored by wildlife and conservation agencies, unlawful trading of crocodiles shows an increasing trend worldwide. Recently, conventional polymerase chain reaction (PCR) and PCR-restriction fragment length polymorphism (RFLP) assays for crocodile have been documented but they are only suitable for identification and cannot quantify adulterations. We described here a quantitative duplex real-time PCR assay with probes to quantify contributions from *Crocodylus porosus* materials simultaneously. A very short amplicon size of 127bp was used because longer targets could have been broken down in samples, bringing considerable uncertainty in molecular analysis. We have validated a TaqMan probe-based duplex real-time PCR (qPCR) assay for the detection of 0.004 ng DNA in pure state and 0.1% target meat in model chicken meatball. False negative detection was eliminated through an endogenous control (141-bp site of eukaryotic 18S rRNA). Analysis of 12 model chicken meatballs adulterated with *C. porosus* reflected 96.3-120.2% target recovery at 0.1-10% adulterations. A validation test of 21 commercial food and traditional medicine (TM) crocodile-based products showed 100% effectiveness. Short amplicon sizes, alternative complementary target, exceptional stability and superior sensitivity suggested the assay could be used for the identification and quantitative determination of *C. porosus* in any food or TM samples even under degraded conditions.

Foffa, D., Johnson, M.M., Young, M.T., Steel, L. and Brusatte, S.L. (2019). Revision of the Late Jurassic deep-water teleosauroid crocodylomorph *Teleosaurus megarhinus* Hulke, 1871 and evidence of pelagic adaptations in Teleosauroidea. PeerJ 7: e6646.

Abstract: Teleosauroids were a successful group of semi-aquatic crocodylomorphs that were an integral part of coastal marine/lagoonal faunas during the Jurassic. Their fossil record suggests that the group declined in diversity and abundance in deep water deposits during the Late Jurassic. One of the few known teleosauroid species from the deeper water horizons of the well-known Kimmeridge Clay Formation is '*Teleosaurus*' *megarhinus* Hulke, 1871, a poorly studied, gracile longirostrine form. The holotype is an incomplete snout from the *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone of Kimmeridge, England. The only other referred specimen is an almost complete skull from the slightly older *A. eudoxus* Sub-Boreal ammonite Zone of Quercy, France. Recently, the validity of this species has been called into question. Here we re-describe the holotype as well as the referred French specimen and another incomplete teleosauroid, DORCM G.05067i-v (an anterior rostrum with three osteoderms and an isolated tooth crown), from the same horizon and locality as the holotype. We demonstrate that all specimens are referable to '*Teleosaurus*' *megarhinus* and that the species is indeed a valid taxon, which we assign to a new monotypic genus, *Bathysuchus*. In our phylogenetic analysis, the latest iteration of the ongoing Crocodylomorph SuperMatrix Project, *Bathysuchus megarhinus* is found as sister taxon to *Aeolodon priscus* within a subclade containing *Mycterosuchus nasutus* and *Teleosaurus cadomensis*. Notably *Bathysuchus* has an extreme reduction in dermatocranial ornamentation and osteoderm size, thickness and ornamentation. These features are mirrored in *Aeolodon priscus*, a species with a well-preserved post-cranial skeleton and a similar shallow and inconspicuous dermal ornamentation. Based on these morphological features, and sedimentological evidence, we hypothesise that the *Bathysuchus* + *Aeolodon* clade is the first known teleosauroid lineage that evolved a more pelagic lifestyle.

Venczel, M. and Codre, V.A. (2019). A new *Theriosuchus*-like crocodyliform from the Maastrichtian of Romania. Cretaceous Research (https://doi.org/10.1016/j.cretres.2019.03.018).

Abstract: We describe a new, small-sized atoposaurid crocodyliform from the Upper Cretaceous (Maastrichtian) of Haţeg Basin, Romania. *Aprosuchus ghirai* gen. nov. sp. nov. is represented by a nearly complete three-dimensional skull with articulating mandibles and an associated fragmentary procoelous cervical vertebra that may have belonged to the same subadult individual. The new taxon possesses a heterodont dentition with at least four distinct tooth morphotypes including pseudocaniniform, pseudoziphodont lanceolate, ziphodont lanceolate and 'low-crowned' teeth. It differs from *Sabresuchus sympiestodon*, the other *Theriosuchus*-like taxon from the same stratigraphic unit, in having less enlarged fang-like teeth, a 'w' shaped naso-frontal articulation and extremely large palpebrals strongly fused to the orbital margin. The new taxon shares with other atoposaurids a broad oreinirostral rostrum, a vascular opening on the dorsal surface of postorbital bar, a small antorbital fenestra, a partially septated choanal groove and symmetrically developed lateral compression of maxillary teeth. Other synapomorphies of *Aprosuchus* are shared by a broader range of taxa including *Wannchampsus* and paralligatorids. The fossil record indicates that these small, highly specialized crocodylomorphs survived up to the latest Cretaceous by colonizing remote and rather complex insular ecosystems in the western Tethyan archipelago.

Hill, A.G., Sandy, J.R. and Begg, A. (2019). Mycotic dermatitis in juvenile freshwater crocodiles (*Crocodylus johnstoni*) caused by *Nannizziopsis crocodili*. Journal of Zoo and Wildlife Medicine 50(1): 225-230.

Abstract: *Nannizziopsis crocodili*, a contagious, keratinophilic fungus, was identified from biopsied tissue in a captive juvenile freshwater crocodile during an outbreak of severe multifocal dermatitis affecting four of five crocodiles. Lesions progressed from superficial, well-demarcated ulceration of scales, to black pigmentation, localized edema, erythema, and flattening of the scales. Treatment with topical enilconazole provided clinical improvement in three of four crocodiles but all developed terminal gout. One crocodile did not develop clinical disease despite long-

term exposure. This is the first report of *N. crocodili* in freshwater crocodiles and in a location remote to the index Australian case.

Hinay, Jr., A., Cadotdot, N.M. and Tablizo, M. (2019). Anti-HIV-1 activity of *Crocodylus mindorensis* (Philippine crocodile) serum in cell-free and cell-associated virus interactions to human peripheral blood mononuclear cells. BioRχiv (doi: https://doi.org/10.1101/596775).

Abstract: Highly-Active Antiretroviral Therapy (HAART) is the recommended treatment and management strategy for HIV infection. Although the existing antiretroviral drugs are indispensably significant in improving the quality of lives of HIV/AIDS individuals, the drugs still have many limitations including resistance, production of toxicity, and their limited availability. These limitations continue to open new opportunities in the use of ethnomedicine for the management of HIV/AIDS. With this, few researchers have made an effort to test the inhibitory activity of crocodile serum as it has a unique and diverse molecular activity in preventing HIV-1 replication. In this study, a cell culture-based assay was utilized coupled with colorimetric enzyme immunoassay to determine the HIV-1 reverse transcriptase activity. One HIV-1 seropositive serum was processed for Peripheral Blood Mononuclear Cells (PBMC) co-culture from which HIV-1 isolates were obtained. The HIV-1 reverse transcriptase activity after 21 days was 0.5928 pg/well. Moreover, a baseline Philippine crocodile serum concentration of 0.5% vol/vol was used based on the previous study conducted by Hinay and Sarol (2018) and the cell viability results showed no cell reduction of mononuclear cells after 72 hours incubation. The inhibitory activity of the Philippine crocodile serum at 0.5% and 0.25% vol/vol concentrations inhibited 65.68±2.93% and 69.92±0.45% respectively in post-infection interactions. In addition, the Philippine crocodile serum in pre-infection interaction at 0.5% and 0.25% vol/vol concentrations inhibited 68.61±1.67% and 69.95±2.24% respectively. As has been noted, the inhibitory actions of the Philippine crocodile serum effectively regulate the HIV-1 replication in both pre- and post-infection interactions.

Bertin, T. (2019). Dynamics and Evolution of Dental Replacement in Amniota. PhD thesis, Claude Bernard University, Lyon, France.

Abstract: Dental replacement consists in the formation of a new tooth which will come take the place of a former tooth, allowing for a renewal of the dental tissues as well as their environment (periodontium). To understand the evolution and the dynamics of tooth replacement, it is necessary to search for a relevant biological model. Because of the strong link between the replacement of teeth and periodontal tissues, I searched the diversity and evolutionary history of tooth replacement, attachment and implantation in extant and fossil amniotes. This work presented two objectives: clarify the terminology associated with replacement, implantation and attachment and review the current knowledges and hypothesis concerning the diversity and the evolution of the three features. In a second part, I studied continuous tooth replacement in archosaurians which present a continuous tooth replacement. First I investigated the teeth of the last groups of toothed-birds. To study the developmental mechanisms of continuous replacement, I studied the mechanisms of dental replacement in the Nile crocodile, through X-ray MicroCT. Nile crocodile's embryos present two type of teeth. The study of the genetic expression of the Notch pathway revealed that surface teeth and submerged teeth present a very similar development, and the main difference is the interruption of the development in the earliest. The Notch pathway also seems to be involved in tooth replacement in this species. In a third part, I studied one alternative to tooth replacement in group which lost the continuous tooth replacement. To do so, I studied the common warthog and the different adaptations of its dentition to highly abrasive diet. I mainly focused of the process of mesial drift, and all the physiological processes associated with drift to understand and recognize this phenomenon.

Schachner, E.R., Richbourg, H.A., Hedrick, B.P. and Diaz, R.E. (2019). Lung architecture in Cuvier's Dwarf caiman (*Paleosuchus palpebrosus*) and the structural diversity of the crocodilian bronchial tree. FASEB Journal 33 (abstract from the Experimental Biology 2019 Meeting).

Abstract: The discovery of unidirectional airflow patterns in the lungs of numerous sauropsids has renewed interest in the evolution, anatomy, and structural diversity of the respiratory structures in archosaurs. In order to understand the origin and evolution of the crocodilian lung, it is first necessary to map out the bronchial architecture across the crocodilian phylogenetic tree. To this end, we describe the anatomy of the respiratory system of Cuvier's dwarf caiman (*Paleosuchus palpebrosus*) based upon micro-computed tomography (uCT) data of the respiratory system *in situ* (n= 4). The lungs were inflated artificially via a syringe, and imaged at total lung capacity. Two *P. palpebrosus* were artificially deflated via a syringe to an approximate functional residual capacity, and re-imaged to visualize changes in the bronchial tree and lung position at the end of a hypothetical natural exhalation. For each of the scans, the lung surface and bronchial tree were segmented into surface models in the scientific visualization program Avizo 7.1. Specific measures of the bronchial tree were acquired in the DICOM viewer OsiriX MD for intraspecific comparisons: (1) the distance from the carina to the first three large secondary bronchi; (2) the area of the primary bronchus at the first three large secondary bronchi; and, (3) the area of the ostium of the first three large secondary bronchi. These data were then compared to the same quantitative measures previously acquired from *Alligator mississippiensis* (n= 10), and *Crocodylus niloticus* (n= 3), allowing for interspecific comparisons across Crocodylia. As expected, the shape of the cartilaginous regions of the bronchial tree were unaffected by changes in the inspiratory volume. Overall, the basic bauplan of the bronchial tree of *P. palpebrosus* is more similar to that of *A. mississippiensis* with fewer large secondary airways (both medial and dorsobronchi), and fewer small secondary saccular bronchi in the caudal and ventral regions of the lung. Additionally, *P. palpebrosus* demonstrates a decreased density of the respiratory parenchyma throughout the lung, similar to the hatchling *A. mississippiensis* and in contrast to the specimens of *C. niloticus*; however, it is possible that this is due to factors unrelated to anatomy or phylogeny, and could be associated with something else entirely (eg environmental conditions).

Knoche, L., Young, B. and Kondrashova, T. (2019). The influence of gravitational gradients on American alligators (*Alligator mississippiensis*). FASEB Journal 33 (abstract from the Experimental Biology 2019 Meeting).

Abstract: Cranial fluids of vertebrae mammals are composed of arterial blood, venous blood, and cerebrospinal fluid that can be altered by orthostatic pressures; head-down postures can elevate intracranial pressure and carotid/jugular luminal area while head up postures produce opposite effects. Previous studies on aquatic and terrestrial snakes showed cardiovascular variation while arboreal snakes showed little cardiovascular variation during orthostatic transitions. Little experimental work regarding orthostatic transitions has been done on alligators. Alligators are known to have unique blood flow patterns due to active regulation of blood flow. The purpose of this study is to investigate the effects of gravitational tilt on vessel luminal diameter and ICP in alligators. Live adult alligators (n= 5, 165-183 cm total length) were subjected to gravitational tilts between 45° head-up to 45° head-down in 15° increments. Short (30 s) and long (120 s) duration tilts were performed to assess barostatic reflex and ICP using ocular ultrasonography, respectively. Vascular ultrasonography was also used to assess luminal diameter of the carotid artery and jugular vein. Instantaneous heart rate was inferred from EKG recordings throughout tilts. Throughout orthostatic transitions, ocular ultrasonography revealed an increase in optic nerve sheath diameter (head down tilts) and a decrease in optic nerve sheath diameter (head up tilts). Head down tilts resulted in jugular and carotid dilation while head up tilts resulted in various jugular

luminal diameters and minimal change in carotid diameter. Heart rate increased at the onset of all orthostatic transitions. There was no evidence for a barostatic response. Ocular ultrasonography was used to non-invasively assess intracranial pressure of reptiles. There was a linear relationship between orthostatic transitions and intracranial pressure due to redistribution of CSF. Compared to previous studies, orthostatic transitions produced similar results on vessel flow and diameter. Variations of vessel flow and diameter may be attributed to unusual patters of heart rate or blood shunts in the cephalic venous system. Increases in heart rate in all rotations may be due to a fear response. Additional studies are needed to further understand the underlying regulatory mechanisms that give rise to the alligator's heart rate and blood flow patterns.

Wang, Q., Kondru, V., Elsey, R.M., Jing, Y. and Feng, J. (2019). Osteocytes in the American alligator (*Alligator mississippiensis*). FASEB Journal 33 (abstract from the Experimental Biology 2019 Meeting).

Abstract: American alligators (*Alligator mississippiensis*) are a large crocodilian living in the southeastern United States of America. Compared to mammals, they have an extended growth period after reaching adulthood. Evolutionarily, they are also one of few vertebrates that have survived long geological periods with conservative morphology. Thus among many aspects related to the growth, development, and physiological adaptions of this long surviving species, the bone biology is interesting in terms of extended bone growth and maintenance, and especially the morphology and behavior of the osteons, the fundamental functional unit in the cortical bone. In this study, alligator bones were analyzed to visualize reptilian osteocytes and compare them to those of mice, the most commonly used mammalian model in bone biology and pharmaceutical studies. In the femora of a one-year-old alligator, the osteon structure of the cortical bone was studied to reveal the density and structure of osteons, as well as the morphology of osteocytes, using confocal imaging by Fluorescein Iso-Thio-Cyanate sample preparation and staining, and osteocyte morphology was visualized using acid-etch SEM. Results demonstrated that in this relatively fast growing individual, there were few osteon-like structures lined along the periosteum and endosteum, indicating a slow rate of bone remodeling. Compared to osteocytes in mice, osteocytes in the alligator specimen were irregular in shape and less evenly distributed, and had fewer dendrites. This study demonstrated the morphology of alligator osteocytes for the first time. The findings indicate that there are significant differences in bone morphology and physiology at the microstructural level between reptiles and mammals; the implications in our understanding of bone biology is yet to be fully understood. This study also suggests that American alligators will be an idea model for studying bone development, adaptation, and evolution at the pre-mammalian stage.

Zhao, L., Fang, L.M., Wan, Q.H. and Fang, S.G. (2019). Male density, a signal for population self-regulation in *Alligator sinensis*. Proc. Biol. Sci. 286(1900): 20190191 (doi: 10.1098/rspb.2019.0191).

Abstract: The regulation of population density is suggested to be indirect and occurs with a time-lag effect, as well as being female centred. Herein, we present a quantitative analysis on the precise, timely and male-dominated self-regulation of Chinese alligator (*Alligator sinensis*) populations. Analysis of 31 years of data revealed gender differences in regulation patterns. Population dynamics were restricted by male density rather than population density, and population growth was halted (birth rate= 0) when male density exceeded 83.14 individuals per hectare, until some males were removed, especially adult males. This rapid and accurate response supports the notions of intrinsic mechanisms and population-wide regulation response. Furthermore, density stress affected mating success rather than parental care to juveniles, i.e. females avoided unnecessary reproduction costs, which may represent an evolutionary advantage. Our findings highlighted the importance of further studies on related physiological mechanisms that focus on four characteristics: quantity breeds quality, gender differences, male density thresholds and nonlinearity.

Liu, G., Wu, Y., Shen, X., Hu, Y., Qin, X., Tian, W., Liu, L., Wang, X. and Shi, X. (2019). Laboratory experiments demonstrate that the hissing of the Chinese alligator can effectively inhibit movement of flower fish *Ptychobarbus kaznakovi*. Hydrobiologia (https://doi.org/10.1007/s10750-019-3943-6).

Abstract: Acoustic barriers, which can deter fish from accessing hazardous areas, have the potential to protect valuable fish stocks. Previous studies have demonstrated that some prey fish species can detect and avoid their predators using sound cues. Such anti-predator responses may be used in acoustic barriers to hinder the movement of prey fish. In this study, the phonotaxic responses of flower fish (Ptychobarbus kaznakovi) were investigated using a playback approach in an outdoor fiberglass tank. By alternating the speakers from which the sounds were emitted and using playbacks of pure tones (500-3000 Hz) as references, the broadband sound from a recording of the Chinese alligator *Alligator sinensis* hissing (0.05-5 kHz) was broadcast using underwater speakers. The numbers of fish responses and transverse swimming speeds were assessed. Only 15% of the flower fish responded to the pure tones with one response, while the fish had an average of 8.4 responses during the 5-min trials when exposed to the broadband sound (sound of the Chinese alligator hissing). The fish reacted to the broadband sound by swimming away significantly faster than they did to the pure tones. Our results suggest that the broadband sound may be an effective deterrent for repelling flower fish.

Finger, Jr., J.W., Hamilton, M.T., Kelley, M.D., Stacy, N.I., Glenn, T.C. and Tuberville, T.D. (2019). Examining the effects of chronic selenium exposure on traditionally used stress parameters in juvenile American alligators (*Alligator mississippiensis*). Arch. Environ. Contam. Toxicol. (https://doi.org/10.1007/s00244-019-00626-9).

Abstract: Environmental contaminants, such as the trace element selenium (Se), are a continuing concern to species worldwide due to their potential pathophysiological effects, including their influence on the stress response mediated through glucocorticoids (GCs; stress hormones). Environmental concentrations of Se are increasing due to anthropogenic activities, including the incomplete combustion of coal and subsequent disposal of coal combustion wastes. However, most studies examining how Se affects GCs have been focused on lower trophic organisms. The objectives of this study were to investigate the effects of long-term Se exposure on traditionally used stress parameters and to identify which of these parameters best indicate Se accumulation in liver and kidney of the American alligator (*Alligator mississippiensis*), a top trophic carnivore found in the southeastern United States and known to inhabit Se-containing areas. Alligators were divided into three dietary treatments and fed prey spiked with 1000 or 2000 ppm of selenomethionine (SeMet) or deionized water (control treatment) for 7 weeks. Following the 7-week treatment protocol, blood and tissue samples were obtained to measure plasma corticosterone (CORT; the main crocodilian GC), tail scute CORT, the ratio of peripheral blood heterophils (H) to lymphocytes (L) as H/L ratio, and body condition. To evaluate which parameter best indicated Se accumulation in the liver and kidney, principal component and discriminant analyses were performed. The only parameter significantly correlated with liver and kidney Se concentrations was scute CORT. Our results suggest that measurement of CORT in tail scutes compared with plasma CORT, H/L ratios, and body condition is the best indicator of Se-exposure and accumulation in crocodilians.

Oommen, M.A., Cooney, R., Ramesh, M., Archer, M., Brockington, D., Buscher, B., Fletcher, R., Natusch, D.J.D., Vana0k, A.T., Webb, G. and Shanker, K. (2019). The fatal flaws of compassionate

conservation. Conservation Biology (doi: 10.1111/cobi.13329).

Abstract: Climate change, overconsumption, land-use intensification, widespread pollution, and other environmentally damaging factors are threatening Earth's biodiversity and its ability to provide ecosystem services essential for human survival. Article impact statement: Wallach *et al*.'s framing of compassionate conservation is flawed and impractical and could be dangerous for people, wildlife, and ecosystems.

Colston, T.J., Kulkarni, P., Jetz, W. and Pyron, R.A. (2019). Phylogenetic and spatial distribution of evolutionary isolation and threat in turtles and crocodilians (non-avian Archosauromorphs). BioRχiv (doi: https://doi.org/10.1101/607796).

Abstract: The origin of turtles and crocodiles and their easily recognized body forms dates to the Triassic. Despite their long-term success, extant species diversity is low, and endangerment is extremely high compared to other terrestrial vertebrate groups, with ~ 65% of ~25 crocodilian and ~360 turtle species now threatened by exploitation and habitat loss. Here, we combine available molecular and morphological evidence with machine learning algorithms to present a phylogenetically-informed, comprehensive assessment of diversification, threat status, and evolutionary distinctiveness of all extant species. In contrast to other terrestrial vertebrates and their own diversity in the fossil record, extant turtles and crocodilians have not experienced any mass extinctions or shifts in diversification rate, or any significant jumps in rates of body-size evolution over time. We predict threat for 114 as-yet unassessed or data-deficient species and identify a concentration of threatened crocodile and turtle species in South and Southeast Asia, western Africa, and the eastern Amazon. We find that unlike other terrestrial vertebrate groups, extinction risk increases with evolutionary distinctiveness: a disproportionate amount of phylogenetic diversity is concentrated in evolutionarily isolated, at-risk taxa, particularly those with small geographic ranges. Our findings highlight the important role of geographic determinants of extinction risk, particularly those resulting from anthropogenic habitat-disturbance, which affect species across body sizes and ecologies.

Rivera-Sylva, H.E., Carbot-Chanona, G., Vivas-González, R., Nava-Rodríguez, L. and Cabral-Valdéz, F. (2019). The first crocodyliforms remains from La Parrita locality, Cerro del Pueblo Formation (Campanian), Coahuila, Mexico. Boletín de la Sociedad Geológica Mexicana (http://dx.doi.org/10.18268/BSGM2019v71n3a).

Abstract: The record of land tetrapods of the Cerro del Pueblo Formation (Late Cretaceous, Campanian), in Coahuila, includes turtles, pterosaurs, dinosaurs, and crocodyliforms. This last group is represented only by goniopholidids, indeterminate eusuchians, and *Brachychampsa montana*. In this work we report the first crocodyliform remains from La Parrita locality, Cerro del Pueblo Formation, based on one isolated tooth, vertebrae, and osteoderms. The association of crocodyliforms, turtles, dinosaurs, and charophyte oogonia provide evidence for stagnant to fluvial environments on a delta plain with tropical climate for the Cerro del Pueblo Formation during the Late Cretaceous.

Simoncini, M.S., Leiva, P.M., Piña, C.I. and Cruz, F.B. (2019). Influence of temperature variation on incubation period, hatching success, sex ratio, and phenotypes in *Caiman latirostris*. Journal of Experimental Zoology (https://doi.org/10.1002/jez.2265).

Abstract: Temperature is crucial for reptiles, also during embryonic development, particularly for species with temperature-dependent sex determination. Under natural conditions, Broadsnouted caiman (*Caiman latirostris*) eggs are influenced by thermal changes in the interior of the nest related to the external environmental temperature. As nests are subject to variations in temperature and most lab studies on crocodilian incubation have been carried out at constant temperatures, we were interested in determining how temperature fluctuations may affect the development of caiman embryos. We investigated the effects of incubation at constant temperatures (31°C, 32°C, and 33°C) and fluctuating temperatures (31 ± 2, 32 ± 1, and 32 ± 2°C) on the following aspects: incubation period duration, hatching success, sex ratio, total length, and body mass of *C. latirostris* hatchlings. Eggs incubated at 31°C produced 100% females, those at 32°C produced 71.6% females (however, the sex ratio was nest related), and at 33°C produced 100% males. We found a masculinizing effect when incubation was at 31 ± 2°C compared with a constant 31°C; and temperature fluctuations at 32°C (32±1 and 32±2°C) had a negative effect on hatchlings size and mass, and hatching success compared with constant incubation temperatures of 32°C and 33°C. Finally, the effect of temperature variation during the incubation period on sex ratio, hatching success, and phenotype depends on the mean temperature, as the fluctuation around 31°C affected the sex ratios and incubation period, and the fluctuation around 32°C affected hatchling success and size.

Campos, Z., Muniz, F. and Magnusson, W.E. (2019). Asynchronous reproduction in three species of crocodilians in south-eastern Amazonia. Journal of Natural History 53(9-10): 585-593.

Abstract: We studied reproduction of three species of crocodilians, *Paleosuchus trigonatus*, *Caiman crocodilus* and *Melanosuchus niger*, in the Xingu River, near the Belo Monte hydroelectric dam. The periods of laying and hatching of eggs were estimated for each nest before (2013-2014) and after (2016-2017) the river was dammed and the reservoir was formed. Nesting of the three species occurred between August and December, butwas largely asynchronous; nest construction peaked in September for *P. trigonatus*, October for *M. niger* and November for *C. crocodilus*. Reservoir filling had little effect on the laying period of any of the species. Nests of *P. trigonatus* and *M. niger* were always within 0-12 m of the bank, whereas nests of *C. crocodilus*, which nests later in the season when flooding is more likely, were up to 100 m from the nearest water body. There was no relationship between distance from water and the number of eggs in nests, suggesting that larger and presumably more experienced females do not lay at different distances from the bank in any of the species.

Campos, Z. (2019). Disruption of reproductive behaviour of black caiman, *Melanosuchus niger* in the Santo Antônio hydroeletric dam, Madeira River, Brazilian Amazon. Herpetological Bulletin 148: 26-28.

Abstract: A female black caiman (*Melanosuchus niger*) was monitored by radio transmitter for three years in the area of Santo Antônio hydroelectric dam in Amazonia. Her nest was inundated during the formation of the reservoir and she abandoned the area and moved to a stream. It is recommended that the formation of new reservoirs is avoided in the three months from October to December to allow caimans to hatch from their eggs before inundation.

Gignac, P.M., O'Brien, H.D., Turner, A.H. and Erickson, G.M. (2019). Feeding in crocodylians and their relatives: Functional insights from ontogeny and evolution. Pp. 575-610 *in* Feeding in Vertebrates, ed. by V. Bels and I. Whishaw. Fascinating Life Sciences, Springer: Cham.

Abstract: Living crocodylians are exceptional ambush predators in near-shore environments. Utilizing a combination of large body size, stealth, and remarkable prey-capture abilities, these apex predators have dominated regions within and around ponds, lakes, rivers, and oceans since the age of the dinosaurs. Cleuren and de Vree (2000), in their contribution to the previous edition of this text (Feeding: Form, Function and Evolution in Tetrapod Vertebrates; Schwenk 2000), provided detailed overviews about the anatomical configurations

and functions of hyolingual anatomy, jaw kinematics, muscle activation patterns, cranial osteology, and hunting behaviors in the context of crocodylian feeding success. In the period since Feeding, there has been mounting interest in the extreme performance of crocodylian jaws and teeth for seizing and subduing prey, as well as the interaction between biomechanical factors, development, and diversification. These efforts have leveraged new technologies, analytical techniques, and phylogenetic comparative frameworks to study living and fossil taxa to address longstanding questions about crocodylian head anatomy from the reciprocal perspectives of ontogeny and evolution. Here, we focus on synthesizing these efforts in order to provide context for interpreting how the development and evolution of performance are thought to have shaped the vertebrate head—as informed by the deep evolutionary history of living crocodylians and their fossil precursors.

Iwasaki, S., Erdoğan, S. and Asami, T. (2019). Evolutionary specialization of the tongue in vertebrates: Structure and function. Pp. 333-384 *in* Feeding in Vertebrates. Fascinating Life Sciences, ed. by V. Bels and I. Whishaw. Springer: Cham.

Abstract: A conspicuous feature of extant tetrapods is a movable tongue that plays a role in food uptake, mastication, and swallowing. The tongue is a muscle mass covered by a mucosal sheath, but the tongues of amphibians, reptiles, birds, and mammals are diverse in general morphology and function. For example, in frogs and toads, a component of the musculus genioglossus serves as an intrinsic tongue muscle, with the anterior part of the tongue attached to the floor of the oral cavity. Nevertheless, these features of the tongue have allowed Anurans to diversify and disperse worldwide. On the other hand, the salamander tongue is connected to the oral cavity by a root with a cartilage or a bony skeleton, and it is mainly comprised of projection and retractor muscles. In this respect, the salamander tongue seems more similar to that of reptiles and mammals than to those of frogs and toads. The morphology and function of the tongues of some reptiles, such as chameleons, and some mammals, such as nectar-feeding bats, are examples of extreme specialization. Finally, the tongue has become almost vestigial in a few species of anurans, turtles, and birds. This review summarizes and discusses many specializations of tongue form and function among tetrapods.

Moss, J. (2019). An Investigation of Seventh Grade Students' Attitudes Towards Animals in a Middle School Science Classroom in Rural Alabama. PhD thesis, Auburn University, Auburn, Alabama, USA.

Abstract: This dissertation examines the different types of attitudes toward animals held by 7th grade students in one middle school in the rural southeastern part United States. This study was conducted using seven-point Likert scale surveys over the course of 5 weeks. Each survey contained twenty items consisting of a wide range of animals across four phyla. These surveys showed that students preferred smaller, local, colorful, vertebrates to other animals. The objective of the study was to determine what types of attitudes students exhibited towards animals presented in the surveys and what influenced these attitudes. The results show that students' attitudes mostly result from knowledge and exposure to a certain species, with aesthetics and perceived threat of the animals used to inform their attitudes in the absence of content knowledge or exposure to the animals. This project also examined students' attitudes and knowledge toward bats and questioned if the bat curriculum would influence these attitudes and science content knowledge. The survey toward bats used pre and post testing items and found that educational intervention did improve attitudes ($t(48) = -6.9$, $p<0.001$) and knowledge X^2 (1, $N= 49) = 19.2$, $p<0.001$ toward bats by a statistically significant amount. Themes discovered that strongly impacted student attitudes toward animals were knowledge, aesthetics, exposure, and taxonomic relation of the animal to other animals.

Cubo, J. and Jalil, N.-E. (2019). Bone histology of *Azendohsaurus laaroussii*: Implications for the evolution of thermometabolism in Archosauromorpha. Paleobiology 45(2): 317-330.

Abstract: This paper is aimed at constraining the phylogenetic frame of the acquisition of endothermy by Archosauromorpha. We analyzed the bone histology of *Azendohsaurus laaroussii*. Stylopodial and zeugopodial bones show three tissue types: (1) avascular lamellar zonal bone formed at low growth rates; (2) a scaffold of parallel-fibered bone containing either small primary osteons or simple vascular canals; and (3) fibrolamellar bone formed at high growth rates. We used quantitative histology to infer the thermometabolic regime of this taxon. We define endothermy as the presence of any mechanism of nonshivering thermogenesis that increases both body temperature and resting metabolic rate. Thus, estimating the resting metabolic rate of an extinct organism may be a good proxy to infer its thermometabolic regime (endothermy vs. ectothermy). High resting metabolic rates have been shown to be primitive for the clade *Prolacerta*-Archosauriformes. Therefore, we inferred the resting metabolic rates of *A. laaroussii*, a sister group of this clade, and of 14 extinct related taxa, using phylogenetic eigenvector maps. All the inferences obtained are included in the range of variation of resting metabolic rates measured in mammals and birds, so we can reasonably assume that all these taxa (including *Azendohsaurus*) were endotherms. A parsimony optimization of the presence of endothermy on a phylogenetic tree of tetrapods shows that this derived character state was acquired by the last common ancestor of the clade *Azendohsaurus*-Archosauriformes and that there is a reversion in Crocodylia.

List, P. (2019). Guided Alligator Tours Or Raccoon Schooling (GATORS). Senior Theses 272 (https://scholarcommons.sc.edu/senior_theses/272).

Abstract: In my two main internships during college, I worked closely with two very different animals: raccoons and alligators. Additionally, I gained experience in presenting educational programs during my internship at Fripp Island, where my most common program was our Gator Walk. For my thesis project, I built upon my experience in interpretive programming, drawing on my experience with alligators and raccoons to develop a unique educational program to present at Congaree National Park. This report will describe the process of developing this program as well as it's implementation and outcomes. In addition, it includes a review of scholarly literature on these two animals which was used to inform the tours.

Hale, M.D., Bertucci, E.M., Rainwater, T.R., Wilkinson, P.M. and Parrott, B.B. (2019). The impact of maternally derived dioxins on embryonic development and hepatic AhR signaling in a long-lived apex predator. Chemosphere (https://doi.org/10.1016/j.chemosphere.2019.04.187).

Abstract: Dioxins and related contaminants are highly pervasive in aquatic systems and elicit deleterious effects in exposed organisms. Because dioxins exhibit a proclivity to bioaccumulate, long-lived predatory species are particularly vulnerable to their persistence in the environment. We have previously reported elevated expression of CYP1A2, a biomarker of dioxin exposure, in American alligator embryos collected from the Tom Yawkey Wildlife Center (YWC). This coastal population inhabits a system with historical dioxin contamination associated with industrial activities. Herein, we utilize ecological attributes of the alligator to address the persistence of dioxins and furans in yolk and their potential to drive changes in hepatic function. Specifically, we assess variation in expression of AHR signaling components in embryos and its connection to contaminant levels in matched yolk samples. Compared to a reference population, TEQ levels and total penta-, hexa-, octa-substituted CDDs were elevated at YWC. Contrary to predictions, TEQ levels were not significantly related to hepatic AHR1B or CYP1A2 expression. However, a significant association was

detected between expression of both factors and embryo:yolk mass ratios, wherein decreasing embryo mass was negatively associated with CYP1A2 but positively associated with AHR1B. These findings suggest that variation in embryonic metabolism and developmental progression likely influence AHR signaling and dioxin toxicity in alligators and potentially other oviparous species. While dioxin concentrations observed in alligators in this study are lower than historical values reported for other wildlife species inhabiting this system, they indicate the continued presence and possible long-term influence of these contaminants in a high trophic status species.

Nilsen, F.M., Bowden, J.A., Rainwater, T.R., Brunell, A.M., Kassim, B.L., Wilkinson, P.M., Guillette, Jr., L.J., Long, S.E. and Schock, T.B. (2019). Examining toxic trace element exposure in American alligators. Environment International 128: 324-334.

Abstract: Toxic trace element exposure occurs through release of the ubiquitous and naturally occurring elements arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg). The unique environmental conditions of the wetland ecosystems along the southeastern Atlantic coast of the United States lead to the accumulation of Hg which is greater than in most other ecosystems in the country. There are also point sources of As, Cd, and Pb in this region. To effectively monitor trace element concentrations, and consequently the potential human exposure, accessible local sentinel species are needed. In this study, concentrations of As, Cd, Pb, Hg and six other trace elements (Al, Ni, Cu, Zn, Se, Mo) were examined in American alligators (*Alligator mississippiensis*) from seven wetland sites in South Carolina and Florida and assessed for their utility as a sentinel species for human trace element exposure. Alligators were chosen as a potential sentinel as they share a common exposure with the local human population through their aquatic diet, and they are directly consumed commercially and through recreation hunting in this region. Sex was significantly related to the concentration of Zn, Mo, and Al, but not As, Pb, Hg, Cd, Se, or Cu. Site specific differences in element concentrations were observed for As, Pb, Hg, Cd, Se, Zn, and Mo. Size/age was significantly related to the element Hg and Pb concentrations observed. The observed concentration ranges for the four toxic elements, As (6-156 ng/g), Cd (0.3-1.3 ng/g), Pb (3-4872 ng/g), and Hg (39-2765 ng/g), were comparable to those previously reported in diverse human populations. In this region alligators are hunted recreationally and consumed by the local community, making them a vehicle of direct human toxic element exposure. We propose that the similarity in As, Cd, Pb, and Hg concentrations between alligators observed in this study and humans underscores how alligators can serve as a useful sentinel species for toxic element exposure.

Tiemensma, M. (2019). Environmental deaths in the Northern Territory of Australia, 2003-2018. Wilderness Environ. Med. Apr (doi: 10.1016/j.wem.2019.03.002).

Abstract: The Northern Territory is sparsely populated with a distinctive climate, geography, and wildlife compared with other states and territories in Australia. Environmental deaths (including drowning, heat-related deaths or environmental exposure, fatal animal attacks or envenomation, and lightning deaths) are reportable to the Northern Territory coroner for further investigation. Databases of the Northern Territory coroner's office and the Royal Darwin Hospital Forensic Pathology Unit were searched to identify all environmental deaths over a 15-y period (1 July 2003-30 June 2018). A total of 4535 cases were reported to the Northern Territory coroner's office during the studied period, of which 167 (4%) were environmental deaths. Drowning was the most common type of environmental death, followed by heat-related deaths and fatal crocodile attacks. Deaths resulting from lightning and animals other than crocodiles are rare. Local resident, male victims in rural locations were the most commonly affected. Alcohol intoxication played a role in about one-third of cases, and in approximately one-third of cases a known underlying medical condition was identified. The Northern Territory has a challenging environment that is hot, humid, remote, and isolated. Circumstantial information and thorough police investigations are essential in the medicolegal investigation of environmental deaths.

Maqsood, I. and Ke Rong (2019). Existing status and resurgence strategies for Chinese alligator (*Alligator sinensis*). Pakistan Journal of Zoology 51(3): 1169-1177.

Abstract: Recently merely two crocodile's species has been enjoying this universe, and one of them is Chinese alligator (*Alligator sinensis*) who is at the edge of extinction in nature. Approximately, 130-150 individuals left in wild. Habitat loss is considered as a major source of population decline of this precious species. Consequently, for the sake of *A. sinensis* conservation, China took steps with the top priority of habitat restoration, controlled management in captive breeding centers, as well as initiation of reintroduction into the wild. Captive breeding centers focused on livestock, controlled sex ratio, promoting growth characteristics, population genetics, and organ preservation. In addition to this, the habitat restoration program committed to improving the quality and habitat area. The reintroduction project illustrated that *A. sinensis* bred in captivity well adapted to wild habitat and successfully reproducing their offspring's. Only healthy crocodiles were selected for release into the wild to renew natural populations. Chinese alligator currently under strict regulation over its commercial use and illegal hunting. All of these strategies give a revival hope to this world most endangered species and give a chance to be part of this ecosystem biodiversity in perspective future. China contributed greatly to conserve ecological and cultural roles of Chinese alligators and its sustainable utilization.

Gignac, P.M., O'Brien, H.D., Turner, A.H. and Erickson, G.M. (2019). Feeding in crocodylians and their relatives: Functional insights from ontogeny and evolution. Pp. 575-610 (Chapter 15) *in* Feeding in Vertebrates, ed. by V. Bels and I.Q. Whishaw. Fascinating Life Sciences. Springer: Cham.

Abstract Living crocodylians are exceptional ambush predators in near-shore environments. Utilizing a combination of large body size, stealth, and remarkable preycapture abilities, these apex predators have dominated regions within and around ponds, lakes, rivers, and oceans since the age of the dinosaurs. Cleuren and de Vree (2000), in their contribution to the previous edition of this text (Feeding: Form, Function and Evolution in Tetrapod Vertebrates; Schwenk 2000), provided detailed overviews about the anatomical configurations and functions of hyolingual anatomy, jaw kinematics, muscle activation patterns, cranial osteology, and hunting behaviors in the context of crocodylian feeding success. In the period since Feeding, there has been mounting interest in the extreme performance of crocodylian jaws and teeth for seizing and subduing prey, as well as the interaction between biomechanical factors, development, and diversification. These efforts have leveraged new technologies, analytical techniques, and phylogenetic comparative frameworks to study living and fossil taxa to address longstanding questions about crocodylian head anatomy from the reciprocal perspectives of ontogeny and evolution. Here, we focus on synthesizing these efforts in order to provide context for interpreting how the development and evolution of performance are thought to have shaped the vertebrate head - as informed by the deep evolutionary history of living crocodylians and their fossil precursors.

Joop, K., Boomker, J., Govender, D. and Mutafchiev, Y. (2019). Nematodes found in Nile crocodiles in the Kruger National Park, South Africa, with redescriptions of *Multicaecum agile* (Wedl, 1861) (Heterocheilidae) and *Camallanus kaapstaadi* Southwell & Kirshner, 1937 (Camallanidae). Systematic Parasitology (https://doi.org/10.1007/s11230-019-09856-w).

Abstract: Sixteen Nile crocodiles were collected in the Kruger

National Park, South Africa and vicinity during 2010 and 2011. A total of 11 nematode species representing six families were recovered. Heterocheilids were the dominant group, comprising five species, with *Dujardinascaris madagascariensis* (Chabaud & Caballero, 1966) being the most prevalent (75%), followed by *Ingwenascaris sprenti* Junker & Mutafchiev, 2017 (68.8%), which was also the second most numerous nematode. While less prevalent (31.3%), *Typhlophoros kwenae* Junker & Mutafchiev, 2017 was the most abundant species. *Micropleura huchzermeyeri* Junker & Mutafchiev, 2017 (Micropleuridae) was collected from five crocodiles and *Crocodylocapillaria* sp. (Capillariidae) occurred in a single host. Three nematodes, *Camallanus kaapstaadi* Southwell & Kirshner, 1937, *Spirocamallanus* sp. (both Camallanidae) and *Ascarophis* sp. (Cystidicolidae), are considered accidental infections, likely ingested with the hosts' prey. Our findings of *D. dujardini* (Travassos, 1920), *D. madagascariensis* and *Multicaecum agile* (Wedl, 1861) in South Africa constitute new geographical records. *Crocodylocapillaria* sp. represents a new host and geographical record, while *T. kwenae*, *I. sprenti* and *M. huchzermeyeri* have been described as new species during the course of this survey. *Multicaecum agile* is here redescribed based on light and scanning electron microscopy. Previously undescribed morphological characters of *C. kaapstaadi*, typically a parasite of *Xenopus* spp. (Amphibia: Pipidae), but here found in two Nile crocodiles, are also presented.

Partyka, J.K. (2019). Parasites and People: Crocodile Parasite Interactions in Human Impacted Areas of Belize. MSc thesis, Norwegian University of Life Sciences, Ås, Norway.

Abstract: Despite the recorded cases of crocodilian epidemic mortalities caused by human disturbance of the environment, there still remains a lack of information to understand how anthropogenic disturbances affect crocodilian health. This study is the first study to investigate the innate immune function, health and parasitism of the American crocodile (*Crocodylus acutus*) and Morelet's crocodile (*Crocodylus moreletii*) in response to human presence and disturbance. More specifically, it focuses on the relationship between the crocodiles and their parasites from various habitats within developed and rural landscapes in Belize. The investigation also examined the host's health response to haemoparasite load, as well as to the presence of the ectoparasite *Paratrichosoma* sp. Parasite load and presence was used to investigate how parasites affect crocodilian health through hematological analysis. These effects were also investigated in connection to human disturbance. All (100%) blood samples contained haemoparasites. In fact, this is the first study to record such a high haemoparasite infection rate in crocodilians, as well as the first study to report the presence of a haemoparasite in Morelet's crocodile (*C. moreletii*). However, results indicate that the haemoparasites found in *C. acutus* and *C. moreletii* do not appear to have an adverse effect on the crocodiles, as they did not affect body condition or correlate with a parasite-specific immune response. Across the two species, 34.5% of all sampled individuals showed traces of infection by the ectoparasitic nematode *Paratrichosoma* sp. and the presence of the parasite did not differ between sites, species, salinity or pH. Similarly, the presence of Paratrichosoma sp. was not found to correlate with body condition, white blood cell recruitment or eosinophil recruitment, and lends more evidence to the notion that this is a benign parasite in crocodilians. Haemoparasite load and the presence of haemoparasites or skin parasites did not differ between site classes, sex or species in Belize. There was, however, a significant lower body condition detected among *C. acutus* who inhabited human developed areas compared to *C. moreletii* who were more commonly encountered in rural areas. There was also a correlation between lower body condition and areas of high anthropogenic disturbance and with increased salinity. This suggest that the lowered body condition in American crocodiles may be related to an unidentified anthropogenic stressor. This investigation uncovered several novel results within the crocodilian research community, nevertheless there is still a need for further studies investigating parasites, immunology, and human disturbance effects in crocodilians.

Martinelli, A.G., Basilici, G., Fiorelli, L.E., Klock, C., Karfunkel, J., Costa Diniz, A., Soares, M.V.T., Marconato, A., Da Silva, J.I., Ribeiro, L.C.B. and Marinho, T.S. (2019). Palaeoecological implications of an Upper Cretaceous tetrapod burrow (Bauru Basin; Peirópolis, Minas Gerais, Brazil). Palaeogeography, Palaeoclimatology, Palaeoecology (https://doi.org/10.1016/j.palaeo.2019.05.015).

Abstract: We describe a globally rare example of a tetrapod burrow from the Upper Cretaceous Bauru Group (Bauru Basin) from Peirópolis, Minas Gerais State, Brazil. The sedimentary succession containing the burrow includes a rich vertebrate assemblage comprising fish, podocnemid turtles, mesoeucrocodylians, saurischian dinosaurs, among others. The burrow is composed of an oblique tunnel (~30°), oval in cross-section, with a horizontal and sub-oval terminal chamber; it is 1.3 m long from the midpoint of its inferred entrance to the midpoint of the bottom of the chamber. It occurs in the upper portion of a sandstone succession, interpreted as a braided channel deposit, and the burrow-fill comprises medium-grained sandstone with mudstone intraclasts derived from fluvial floodplain facies. it is overlain by other fluvial channel deposits. Analyses suggest that the burrow was dug after the filling of the braided channel and during the pedogenesis of its exposed upper surface. Based on burrow morphology and size, the most plausible producer of this burrow is a notosuchian mesoeucrocodylian, such as small to mid-sized notosuchians (eg sphagesaurids). The Bauru Group has an extensive fossil record of notosuchians with disparate morphologies, and it is noteworthy that the small-sized notosuchian *Labidiosuchus amicum* comes from the same unit as the burrow. Moreover, arid to semi-arid conditions have been inferred for fossil-bearing rocks of this unit, and as such the data here presented add to our palaeoecological knowledge of Cretaceous mesoeucrocodylians in Gondwana. Moreover, it constitutes a new Cretaceous record of a tetrapod burrow during a period when such ichnofossils are globally rare.

Janovcová, M., Rádlová, S., Polák, J., Sedlácková, K., Peléšková, S., Žampachová, B., Frynta, D. and Landová, E. (2019). Human attitude toward reptiles: A relationship between fear, disgust, and aesthetic preferences. Animals 9(238) (doi:10.3390/ani9050238).

Simple Summary: Although there are many articles about reptiles, no one has ever studied the human perception of reptiles as a whole, a group that would include representatives of dierent taxonomic clades. Thus, we designed a study of human perception of all reptiles focusing on the relationship between perceived fear, disgust, and aesthetic preferences. Respondents evaluated various reptile images and the results revealed that people tend to perceive them as two clearly distinct groups based on their similar morphotype - legless reptiles (incl. snakes) and other reptiles with legs. In the case of snakes, the most feared species also tend to be perceived as beautiful. Compared to the most feared reptiles with legs (lizards, turtle, crocodiles), the legless once tend to be perceived as more disgusting. In both groups, species perceived as the least beautiful were the same as those rated as the most disgusting. Thus, reptiles cannot be rated as both beautiful and disgusting at the same time.

Abstract: Focusing on one group of animals can bring interesting results regarding our attitudes toward them and show the key features that our evaluation of such animals is based on. Thus, we designed a study of human perception of all reptiles focusing on the relationship between perceived fear, disgust, and aesthetic preferences and dierences between snakes and other reptiles. Two sets containing 127 standardized photos of reptiles were developed, with one species per each subfamily. Respondents were asked to rate the animals according to fear, disgust, and beauty on a seven-point Likert scale. Evaluation of reptile species shows that people tend to perceive them as two clearly distinct groups based on their similar morphotype. In a subset of lizards, there was a positive correlation

between fear and disgust, while disgust and fear were both negatively correlated with beauty. Surprisingly, a positive correlation between fear and beauty of snakes was revealed, ie the most feared species also tend to be perceived as beautiful. Snakes represent a distinct group of animals that is also reflected in the theory of attentional prioritization of snakes as an evolutionary relevant threat.

Soares, D. and Bierman, H. (2018). Crocodilia sensory systems. *In* Encyclopedia of Animal Cognition and Behavior, ed. by J. Vonk and T.K. Shackelford. Springer Nature: Switzerland.

Reber, S.A. (2018). Crocodilia communication. *In* Encyclopedia of Animal Cognition and Behavior, ed. by J. Vonk and T.K. Shackelford. Springer Nature: Switzerland.

Ristevski, J. (2019). Crocodilia morphology. *In* Encyclopedia of Animal Cognition and Behavior, ed. by J. Vonk and T.K. Shackelford. Springer Nature: Switzerland.

Sookias, R.B. (2019). Exploring the effects of character construction and choice, outgroups and analytical method on phylogenetic inference from discrete characters in extant crocodilians. Zoological Journal of the Linnean Society (https://doi.org/10.1093/zoolinnean/zlz015).

Abstract: Phylogenies for fossil taxa must be inferred from morphology, but accuracy of inference is questionable. Here, morphological characters for extant crocodilians are investigated to assess how to improve inference accuracy. The homoplasy of characters is assessed against a DNA-based phylogenetic tree. Cranial characters are significantly less homoplastic, but this result is perhaps confounded by research effort. Meristic characters are significantly more homoplastic and should be used with caution. Characters were reassessed first hand and documented. Those characters passing tests of robust construction are significantly less homoplastic. Suggestions are made for means to improve coding of discrete characters. Phylogenies inferred using only robust characters and a reassessed matrix, including corrected scorings, were not overall closer to the DNA tree, but did often place the gharial (*Gavialis*) in a position agreeing with or closer to it. The effects of the choice of analytical method were modest, but Bayesian analysis of the reassessed matrix placed *Gavialis* and *Mecistops* (slender-snouted crocodile) in DNA-concordant positions. Use of extant rather than extinct outgroups, even with the original matrix, placed *Gavialis* in a more DNA-concordant position, as did factoring out 3D skull shape. The morphological case for placement of *Gavialis* outside other extant crocodilians is arguably overstated, with many characters linked to skull shape.

Alston, B.M. (2019). Humoral Immune Responses to Select Bacterial Pathogens in the American Alligator, *Alligator mississippiensis*. MSc thesis, Clemson University, Clemson, South Carolina, USA. All Theses 3135.

Abstract: The American alligator, *Alligator mississippiensis*, is widely distributed and abundant throughout the southeastern United States. Despite their abundance, these reptiles have not been examined for their role in environmental pathogen distribution, as a sentinel for the presence of various pathogens, or other humoral immune responses in individuals from different habitats. This study investigates the humoral immune responses of alligators to select bacterial pathogens. Immunoglobulin Y (IgY), an immunoglobulin molecule found in amphibians, birds and reptiles, similar to IgG in higher vertebrates. IgY was purified from pooled alligator serum collected in coastal South Carolina. Mouse polyclonal antisera (pAb) was then generated against IgY to develop a sensitive ELISA to quantify serum antibody responses and relative titers. Serum samples from alligators collected from multiple localities in Florida were screened for bacteria-specific antibodies to the following 9 aquatic bacteria: *Vibrio cholera*, *Escherichia coli*, *V. anguillarum*, *V. vulnificus*, *V. parahaemolyticus*, *Brevundimonas vesicularis*, *Mycobacterium marinum*, *Erysipelothrix rhusiopathiae* and *Streptococcus agalactiae*. C-reactive protein (CRP) is an ancient acute phase protein, participating in complement activation and opsonisation of pathogens, and is usually indicative of relative levels of systemic inflammation. Alligator CRP was purified and used to generate a specific monoclonal antibody to develop ELISA-based approaches to semiquantifying circulating CRP in individuals. Finally, serum lysozyme enzymatic activity was also quantified in individual samples. Humoral immune responses to various pathogens, along with CRP and lysozyme activity, may be correlated with environmental health. This study provides the first baseline data and proof of concept, to compare responses of wild alligators to pathogens throughout their distribution. This information will allow *A. mississippiensis* to be used as a sentinel of pathogen occurrence and environmental quality in future studies.

Tyler, J., Achatz, T.J., Pulis, E.E., Junker, K., Binh, T.T., Snyder, S.D. and Tkach, V.V. (2019). Molecular phylogeny of the Cyathocotylidae (Digenea, Diplostomoidea) necessitates systematic changes and reveals a history of host and environment switches. Zoologica Scripta (https://doi.org/10.1111/zsc.12360).

Abstract: The Cyathocotylidae is a globally distributed family of digeneans parasitic as adults in fish, reptiles, birds and mammals in both freshwater and marine environments. Molecular phylogenetic analysis of interrelationships among cyathocotylids is lacking with only a few species included in previous studies. We used sequences of the nuclear 28S rRNA gene to examine phylogenetic affinities of 11 newly sequenced taxa of cyathocotylids and the closely related family Brauninidae collected from fish, reptiles, birds and dolphins from Australia, Southeast Asia, Europe, North America and South America. This is the first study to provide sequence data from adult cyathocotylids parasitic in fish and reptiles. Our analyses demonstrated that the members of the genus *Braunina* (family Brauninidae) belong to the Cyathocotylidae, placing the Brauninidae into synonymy with the Cyathocotylidae. In addition, our DNA sequences supported the presence of a second species in the currently monotypic *Braunina*. Our phylogeny revealed that *Cyathocotyle* spp. from crocodilians belong to a separate genus (Suchocyathocotyle, previously proposed as a subgenus) and subfamily (Suchocyathocotylinae subfam. n.). Morphological study of *Gogatea serpentum indicum* supported its elevation to species as *Gogatea mehri*. The phylogeny did not support *Holostephanoides* within the subfamily Cyathocotylinae; instead, *Holostephanoides* formed a strongly supported clade with members of the subfamily Szidatiinae (*Gogatea* and *Neogogatea*). Therefore, we transfer *Holostephanoides* into the Szidatiinae. DNA sequence data revealed the potential presence of cryptic species reported under the name *Mesostephanus microbursa*. Our phylogeny indicated at least two major host switching events in the evolutionary history of the subfamily Szidatiinae which likely resulted in the transition of these parasites from birds to fish and snakes. Likewise, the transition to dolphins by *Braunina* represents another major host switching event among the Cyathocotylidae. In addition, our phylogeny revealed more than a single transition between freshwater and marine environments demonstrated in our dataset by *Braunina* and some *Mesostephanus*.

Lawson, A. (2019). Reducing Uncertainties in Conservation Decision Making for American Alligators. PhD thesis, Clemson University, Clemson, South Carolina, USA. All Dissertations 2333.

Abstract: Effective conservation decision-making necessitates monitoring programs that are designed to collect unbiased and precise measurements of relevant attributes deemed to reduce structural uncertainty of the managed resource state. American

alligators (*Alligator mississippiensis*; hereafter alligator) are a keystone species within the southeastern United States that have cascading effects on ecosystem structure and function, and are managed under consumptive use management programs throughout their range. Management of alligator populations in South Carolina is challenging due to pervasive uncertainties regarding the size class distribution, which is only partially observable using the primary monitoring tool (nightlight surveys), a lack of demographic parameter estimates, and identification of measurable attributes that could pose conservation threats (eg drought, contaminants). My objective was to develop analytical tools to reduce partial observability in alligator monitoring and identify potential drivers of alligator population dynamics to reduce structural uncertainty. I developed a Bayesian integrated population model (IPM) that produced among the first demographic parameter estimates for alligators in South Carolina and determined that survival probabilities increased greatly among immature size classes, but are relatively similar among adults (>0.90); a pattern that has been previously reported for American crocodiles (*Crocodylus acutus*). The IPM produced size-class specific abundance estimates for alligators from count data with prolific state uncertainty (>60% unknown size observations). In general, alligator abundance trends were uncertain and appeared to vary spatially, though the mean population growth (λ) estimates for all sites, IPM versions, and the Lefkovtich matrix were <1, indicating a population decline. However, the 95% Bayesian credible intervals for λ at one survey site included 1, indicating some uncertainty. I then used the demographic parameter estimates to simulate virtual alligator populations under varying gradations of initial population density, harvest rate to determine an optimal level of spatiotemporal replication for a monitoring programs. To evaluate the need to obtain size class-specific abundance estimates, the simulated count data from the underlying virtual population was total individuals (of all size classes). Based on fundamental objectives to maximize financial effectiveness and minimize management and ecological uncertainty, all of the harvest and density scenarios (except low density and maximum harvest) selected a monitoring program with six temporal replicates (the maximum) and 320 spatial replicates (1 spatial replicate = 0.5 km river segment). In general, data reliability (precision and accuracy) was more sensitive to increasing temporal, compared to spatial, replication, which has been previously reported in other simulation based studies in which detection probabilities are low ($p < 0.10$). Moreover, all scenarios and monitoring programs induced changes in alligator size class structure, though the effects were minimized with reduced harvest rate, increase survey effort and population density. In synthesis, the demographic parameter estimates produced by the IPM can and are being used to improve monitoring methodology for alligators in South Carolina, and provide a mechanism to increase the demographic resolution of monitoring data, inform optimal monitoring decisions, and explore further uncertainties associate with harvest decisions. Finally, to better elucidate potential drivers of alligator population status, I evaluated total mercury (THg) concentrations in adult alligator whole blood from a longitudinal mark-recapture study. I determined that THg in whole blood was best described by an interactive effect of sex and predicted age, as calculated by predicted age at first capture using a recently developed growth model for alligators in South Carolina. THg concentrations averaged 0.16 ± 0.05 mg kg^{-1} ww and were slightly higher in males than female, though the overall average is significantly lower than other estimates reported in the Florida Everglades and the Savannah River Site in South Carolina. The quadratic effect of THg with predicted age, in which older individuals had lower levels than younger individuals is novel, and contrasts with previous assumptions that THg bioaccumulates with age (ie does not decrease). We posit that determinate (asymptotic) growth, which could accompany age-related changes in foraging patters and metabolism, could potentially explain the lower THg we detected in the oldest individuals. The results from our study could highlight the need for longterm longitudinal monitoring of sentinel species to further evaluate our hypotheses.

Harris, S.N., Holmes, J.B. and Jachowski, D.S. (2019). First record of consumption of a *Spilogale putorius* (Eastern spotted skunk) by an *Alligator mississippiensis* (American alligator). Southeastern Naturalist 18(2) (https://doi.org/10.1656/058.018.0201).

Abstract: Here, we detail the first confirmed consumption of a *Spilogale putorius* (Eastern Spotted Skunk) by an *Alligator mississippiensis* (American alligator, hereafter, alligator). In April 2017 in Osceola County, FL, we tracked a radio-collared Eastern spotted skunk to a wetland and discovered its remains inside the stomach of a deceased alligator. We conducted a necropsy on the alligator, but were unable to definitively determine the cause of mortality for either the alligator or the Eastern spotted skunk. We believe this event represents the first record of a crocodilian predating a mephitid. Although the cause of the alligator's death was unconfirmed, we believe there is a possibility that the alligator succumbed due to toxicosis brought on by its digestion of Eastern spotted skunk spray.

Sobral, G. and Müller, J. (2019). The braincase of *Mesosuchus browni* (Reptilia, Archosauromorpha) with information on the inner ear and description of a pneumatic sinus. PeerJ 7: e6798.

Abstract: Rhynchosauria is a group of archosauromorph reptiles abundant in terrestrial ecosystems of the Middle Triassic. *Mesosuchus* is one of the earliest and basalmost rhynchosaurs, playing an important role not only for the understanding of the evolution of the group as a whole, but also of archosauromorphs in general. The braincase of *Mesosuchus* has been previously described, albeit not in detail, and the middle and inner ears were missing. Here, we provide new information based on micro-computed tomography scanning of the best-preserved specimen of *Mesosuchus*, SAM-PK-6536. Contrary to what has been stated previously, the braincase of *Mesosuchus* is dorso-ventrally tall. The trigeminal foramen lies in a deep recess on the prootic whose flat ventral rim could indicate the articulation surface to the laterosphenoid, although no such element was found. The middle ear of *Mesosuchus* shows a small and deeply recessed fenestra ovalis, with the right stapes preserved in situ. It has a rather stout, imperforated and posteriorly directed shaft with a small footplate. These features suggest that the ear of *Mesosuchus* was well-suited for the detection of low-frequency sounds. The semicircular canals are slender and elongate and the floccular fossa is well-developed. This is indicative of a refined mechanism for gaze stabilization, which is usually related to non-sprawling postures. The most striking feature of the *Mesosuchus* braincase is, however, the presence of a pneumatic sinus in the basal tubera. The sinus is identified as originating from the pharyngotympanic system, implying ossified Eustachian tubes. Braincase pneumatization has not yet been a recognized feature of stem-archosaurs, but the potential presence of pneumatic foramina in an array of taxa, recognized here as such for the first time, suggests braincase sinuses could be present in many other archosauromorphs.

Lauprasert, K., Watchajittaphan, P., Juanngam, S. and Bhuttarach, S. (2019). Freshwater crocodile, *Crocodylus siamensis* Schneider, 1801, from the Middle Pleistocene deposits in Chaloem Phrakiat District, Nakhon Ratchasima, Thailand. Annales de Paléontologie (https://doi.org/10.1016/j.annpal.2019.05.002).

Abstract: Two crocodilian anterior cranium parts from Takut Khon Village sand pit, Chaloem Phrakiat District, Nakhon Ratchasima Province, are presently described. Their morphology indicates that the specimens belong to a single species based on the presence of several similar characters such as a hole for the reception of the first dentary tooth at the anterior edge of the premaxillary bone; anterior tip of nasal elongate and projecting into the posterior margin of the external nares; wavy suture line between the posterior part of the nasal with the anterior margin of prefrontal and frontal processes. The cranium morphology is extremely close to *Crocodylus siamensis* Schneider, 1801 (Siamese crocodile) and conforming the existence of *C. siamensis* from the Middle Pleistocene in Thailand.

Spalding, M. and Parrett, C.L. (2019). Global patterns in mangrove recreation and tourism. Marine Policy (https://doi.org/10.1016/j.marpol.2019.103540).

Abstract: The use of mangroves as a travel and tourism destination has not received much attention, but provides a high-value, low impact use of these important ecosystems. This work quantifies and maps the distribution of mangrove visitation at global scales using keyword searches on user-generated content of the popular travel website, TripAdvisor. It further explores the use of user-generated content to uncover information about facilities, activities and wildlife in mangrove tourism locations world-wide. Some 3945 mangrove "attractions" are identified in 93 countries and territories. Boating is the most widespread activity, recorded in 82% of English-language sites. Birdlife is recorded by visitors in 28% of sites, with manatees/dugongs and crocodiles/alligators also widely reported. It is likely that mangrove tourism attracts tens to hundreds of millions of visitors annually and is a multi-billion dollar industry.

Powell, G., Versluys, T.M.M., Williams, J., Tiedt, S. and Pooley, S. (2019). Using environmental niche modelling to investigate the importance of ambient temperature in human-crocodilian attack occurrence for two species of crocodilian. Oryx

Abstract: Crocodilians are responsible for more attacks on people than any other large predator, which has important implications for human safety and crocodilian conservation. Understanding the drivers of crocodilian attacks on people could help minimise future attacks and inform conflict management. Crocodilian attacks follow a seasonal pattern for many species; however, there has been limited analyses of the relationship between fine-scale contemporaneous environmental conditions and atack occurrence. Here, we use methods from environmental niche modelling to explore the relationships between abiotic predictors and human attack occurrence at a daily temporal resolution for two species: the Nile crocodile (*Crocodylus niloticus*) in South Africa and Swaziland (renamed Eswatini), and the American alligator (*Alligator mississippiensis*) in Florida. Our results indicate that ambient daily temperature in the most important abiotic temporal predictor of attack occurrence for both species, with attack likelihood increasing sharply at temperatures above 18°C and peaking at 28°C. It is likely that this relationship is explained partially by human propensity to spend time in and around water in warmer weather, but also by the effect of temperature on crocodilian hunting behaviour and physiology, especially the ability to digest food. We discuss the potential of our findings to contribute to the management of crocodilians, with benefits for human safety and conservation, as well as the application of environmental niche modelling to analysing human conflict with other species, including ectotherms and endotherms.

Lopez Gonzalez, E.C., Siroski, P.A. and Poletta, G.L. (2019). Genotoxicity induced by widely used pesticide binary mixtures on *Caiman latirostris* (broad-snouted caiman). Chemosphere 232: 337-344.

Abstract: In this study, we investigated the effects of three binary mixtures of pesticide formulations commonly used in soybean crop: Cypermethrin Atanor® (25% -CYP), Chlorpyrifos Lorsban 48E® (48% -CPF) and Glyphosate Roundup® Full II (66.2% -GLY) on broad-snouted caiman (*Caiman latirostris*) hatchlings exposed by voluntary immersion under controlled condition. Genotoxicity was evaluated in peripheral blood erythrocytes through the micronucleus (MN) test and other nuclear abnormalities (NAs) and be sides, growth of caiman was analyzed in each experimental group. The results showed that pesticide formulations tested, at concentrations similar to those recom mended for application in the field, induced an increase in the frequency of micronucleus (FMN; p= 0.001) and Notched nuclei (NN; p= 0.010) in the mixture CYP + CPF, while an increase in the frequency of buds and NN was observed in the mixture of GLY + CYP (Pbuds= 0.016 and PNN= 0.021), compared to the vehicle control (VC). On the contrary, a possible antagonistic action was observed between the components in the mixture GLY + CPF. Growth was not affected in any exposed groups (p>0.05). There was a clutch effect in the frequency of binucleated erythrocytes (BiN; p= 0.011), total length (TL; p= 0.001) and snout-vent length (SVL; p= 0.031). Biomarkers used in this study are considered important predictive tools for the evaluation of xeno biotics. In this study, we demonstrated genotoxicity of pesticide mixtures under conditions that simulate the real situation of exposure suffered by caiman and other wild species in Argentina.

Narváez, I., Brochu, C.A., De Celis, A., Codrea, V., Escaso, F., Pérez-García, A. and Ortega, F. (2019). New diagnosis for *Allodaposuchus precedens*, the type species of the European Upper Cretaceous clade Allodaposuchidae. Zoological Journal of the Linnean Society (https://doi.org/10.1093/zoolinnean/zlz029).

Abstract: *Allodaposuchus precedens* is a basal member of Eusuchia, which was established almost a century ago on a set of cranial and postcranial fragmentary remains from the lower Maastrichtian of Vălioara, Romania. It was the first described member and type species of Allodaposuchidae, a recently described European clade representing one of the nearest outgroups to Crocodylia. Although our understanding of the group has expanded in recent years through the description of new forms, a review of *Al. precedens* is needed. The detailed revision of the classical material from Vălioara, including cranial and postcranial remains, and a comparison with the nearly complete skull from the Romanian synchronous locality of Oarda de Jos, allows us to emend the diagnosis for *Al. precedens*.

Barreiros, J.P. and Haddad, V. (2019). Occurrence, causes and consequences of predator attacks to humans. European Journal of Zoological Research 7(1): 10-18.

Abstract: Attacks on humans by predators occur worldwide. This paper analyzes several documented and reported attacks in the available literature and discusses the causes and consequences of this type of human-wildlife conflict. We make a characterization of types of attacks and discuss a possible biased report of accidents between developed countries and exotic places with increased ecotourism activities. Finally, we propose a set of major suggestions to minimize both accidents and conflicts with predatory wildlife. We provide here a thorough comprehensive discussion on the following main topics: a) why predators attack humans, b) why accidents are apparently increasing and c) how to better report those accidents in order to make them available for proper study by the scientific community. The need to reduce the number of attacks and conflicts with wildlife is crucial for the safety of populations living close to protected areas, predator conservation and, sustained and safe development of ecotourism.

Cohen, E. (2019). Crocodile tourism: The emasculation of ferocity. Tourism Culture & Communication 19(2): 83-102.

Abstract: Departing from Franklin's approach to the wild animal in tourism, and Cohen's typology of differentially framed settings, this article seeks to show that, as practices dealing with crocodiles moved from extermination in natural settings to interaction with tourists in different settings, the crocodile was emasculated and its perception was transformed from a dangerous, ferocious animal, to a pliable, pet-like one. The progressive exacerbation of that process is examined in a comparative study of crocodile tourism in three regions of the globe, in which different species of crocodilians constitute a significant tourist attraction: northern Australia, Florida in the US, and central Thailand. The article calls attention to the one-sidedness of current studies of tourist-crocodile encounters, which prioritize the tourists' experiences but disregard those of the crocodiles, and introduces some novel paradigmatic approaches to tourist–animal encounters, which could help to overcome this

limitation.

Rosel, A., Sari, S.A.T. and Hasanah, U.U. (2019). Anatomical study of caudal vertebrae of estuary crocodile (*Crocodylus porosus*), chameleon (*Bronchocela jubata*) and klarap (*Draco volans*). Proceeding International Conference on Science and Engineering 2: 3-7.

Abstract: Reptile tails have a unique function as self defense, autotomy, and maintaining balance while in nature. There are several species that do not have an autotomy function, these species include Estuary Crocodile (*Crocodylus porosus*), Java Chameleon (*Bronchocela jubata*), and Klarap (*Draco volans*). The species is a reptile class that uses its tail with different functions. Differences in function in the tail can be caused by differences in anatomical structure, morphology, and behavioral adaptations that are owned by each species. With the differences in each species, this study aims to get a comparative picture of the caudal vertebrae (coccyx) anatomy of species of estuary crocodile (*C. porosus*), java chameleon (*B. jubata*), and klarap (*D. volans*) so that anatomical comparison can be seen in each species that affects the difference in tail function. The method used in this study is morphological observation with boiled method, X-Ray method, and Alizarin Red's and Alcian Blue staining methods. Research that has been conducted shows that the anatomical structure of caudal vertebrae (coccyx) in estuary crocodile species has a larger bone structure than the bone structure of java chameleon and klarap. The anatomical structure of caudal vertebrae (coccyx) in klarap has a smaller bone structure than estuary crocodile and java chameleon. The anatomical structure of caudal vertebrae (coccyx) in java chameleon species has a longer bone structure than its body length. Caudal vertebrae of these three species do not have tail fracture fields.

Chen, W.M., Xie, Y.R., Young, C.C. and Sheu, S.Y. (2019). *Inhella crocodyli* sp. nov., isolated from a crocodile pond. International Journal of Systematic and Evolutionary Microbiology (doi: 10.1099/ijsem.0.003496).

Abstract: Strain CCP-18T, isolated from a freshwater pond in Taiwan, was characterized by using a polyphasic taxonomy approach. Phylogenetic analyses based on 16S rRNA gene sequences indicated that strain CCP-18T belongs to the genus *Inhella* and has the highest levels of sequence similarity with respect to *Inhella inkyongensis* IMCC1713T (98.9%) and *Inhella fonticola* TNR-25T (98.0%). Cells were Gram-stain-negative, aerobic, motile, rod-shaped and formed white-coloured colonies. Optimal growth occurred at 25 °C, pH 6 and in the absence of NaCl. The major fatty acids of strain CCP-18T were summed feature 3 (comprising C16:1ω7c and/or C16:1ω6c) and C16:0. The polar lipid profile consisted of phosphatidylethanolamine, phosphatidylglycerol, diphosphatidylglycerol, two unidentified aminophospholipids, an unidentified phospholipid, an unidentified aminolipid and an unidentified lipid. The predominant polyamine was putrescine. The major isoprenoid quinone was Q-8. The draft genome was approximately 3.76 Mb in size with a G+C content of 68.9 mol%. The DNA-DNA hybridization values for strain CCP-18T with *I. inkyongensis* IMCC1713T and *I. fonticola* TNR-25T were less than 40%. Based on the phylogenetic and phenotypic data, strain CCP-18T should be classified within the genus *Inhella* as a representative of a novel species, named *Inhella crocodyli* sp. nov. The type strain is CCP-18T (=BCRC 81120T=LMG 30595T=KCTC 62511T).

Sheu, S.Y., Xie, Y.R., Kwon, S.W., Sheu, C. and Chen, W.M. (2019). *Sphingomonas crocodyli* sp. nov., isolated from a crocodile pond. International Journal of Systematic and Evolutionary Microbiology (DOI: 10.1099/ijsem.0.003455).

Abstract: Strain CCP-7T, isolated from a freshwater pond in Taiwan, was characterized using a polyphasic taxonomy approach. Phylogenetic analyses based on 16S rRNA gene sequences and coding sequences of 92 protein clusters indicated that strain CCP-7T formed a phylogenetic lineage in the genus *Sphingomonas*. Strain CCP-7T was most closely related to *Sphingomonas starnbergensis* 382T and *Sphingomonas naphthae* DKC-5-1T with 96.2% 16S rRNA gene sequence similarity. Strain CCP-7T showed 65.5-76.7% average nucleotide identity and 20.2-22.5% digital DNA-DNA hybridization identity with the strains of other related *Sphingomonas* species. Cells were Gram-stain-negative, aerobic, motile, rod-shaped and formed light orange-coloured colonies. Optimal growth occurred at 30 °C, pH 6 and in the absence of NaCl. The major fatty acid of strain CCP-7T was C18:1ω7c. The polar lipid profile consisted of phosphatidylethanolamine, phosphatidylglycerol, diphosphatidylglycerol, phosphatidylmonomethylethanolamine, three uncharacterized sphingoglycolipids, two uncharacterized phospholipids and six uncharacterized lipids. The predominant polyamine was homospermidine. The only isoprenoid quinone was Q-10. Genomic DNA G+C content of strain CCP-7T was 64.5%. On the basis of phenotypic and genotypic properties and phylogenetic inference, strain CCP-7T should be classified in a novel species of the genus *Sphingomonas*, for which the name *Sphingomonas crocodyli* sp. nov. is proposed. The type strain is CCP-7T (=BCRC 81096T=LMG 30311T=KCTC 62190T).

Amoah, E., Gray, C.L. and Gumbs, R. (2019). A Survival Blueprint for the conservation and management of the West African slender-snouted crocodile, *Mecistops cataphractus* in the Jimi River (Obuasi) and Tano River (Tanoso), Ghana. An output from the EDGE of Existence fellowship, Zoological Society of London.

Tokarski, M. (2019). Discomforting encounters with nature as moral experiences. Pp. 125-148 *in* Hermeneutics of Human-Animal Relations in the Wake of Rewilding. The International Library of Environmental, Agricultural and Food Ethics, Vol. 30. Springer: Cham

Abstract: One of the most common themes in environmentalist writings has been that of leaving civilization to submerge oneself in wilderness that is full of threats and potentially deadly. One of the motives for such adventures has been to open oneself to the full force of nature and potentially become transformed by it. Such transformation is defined here as a moral experience, and a hermeneutic analysis of one such experience - Val Plumwood's encounter with a crocodile - is carried out. While such experiences have been usually associated with wilderness adventures, it is argued that what is really important is to encounter wild entities capable of denying human appropriations of nature, and this can take place anywhere. Indeed, ecological discomforts experienced close to home are proposed as a more radical version of wilderness experience in which we encounter alternative interpretations of human identity and even of moral concepts like for instance 'justice'.

Rahim, A., Gabol, K., Ahmed, W., Manzoor, B. and Batool, A. (2018). Population assessment, threats and conservation measures of marsh crocodile at Dasht River, Gwadar. Pakistan Journal of Marine Sciences, 27(1): 45-53.

Abstract: Dasht River is the largest seasonal river in District Gwadar and Turbat which is fed by Nehang and Kech Rivers. The river and its tributariesare good habitat of Marsh crocodile (*Crocodylus palustris*). Population census of the species revealed that there is a sharp decline in their numbers and are some serious threat to crocodile at Dasht like predation of their eggs by feral dogs, shooting by local people, habitat destruction like construction of dams and agricultural activities, illegal smugglings of crocodile juveniles and frequent tropical cyclones/high floods in the area. There was an alarming decline in the populations during a period of 10 years. There were 99 crocs of the species in 2007-8 having 63 adults, 18 sub adults and 18 juveniles which reduced to only 25

crocs having 23 adults and only 2 juveniles in 2017-18. The decline of adult population and absence of offsprings indicates that the reproduction is not taking place, which is a highly unhealthy and dangerous situation. The habitat degradation needs to be controlled. The current conservation program like might the species which is classified as endangered must be considered for a status of critically endangered species.

Loriza, V.E., Kusrini, M.D. and Meilani, R. (2019). Persepsi pengunjung terhadap buaya muara (*Crocodylus porosus*) dan fasilitas pemeliharaan di penangkaran dan kebun binatang. Scripta Biologica (available at: http://journal.bio.unsoed.ac.id/index.php/scribio/article/view/976)

Abstract: Estuarine crocodile often considered as dangerous animal due to continual news of human crocodile conflict cases around the world. This study aimed to analyze the perception of visitors about estuarine crocodile in captivity and facilities in two captive breeding sites. We conducted field observation and structured interview to 120 respondents in two local zoos: the Indonesia Jaya Crocodile Park (TBIJ or crocodile park) in Bekasi and Ragunan Zoo (TMR or the zoo) in Jakarta. All visitors have low knowledge about estuarine crocodile, which they obtained mostly from mass media. Although most visitors know that estuarine crocodies are protected however in pratice they don't have enough empathy to captive crocodiles. Visitors to both areas are local who lives near the vicinity of the park or zoo. Crocodile park visitors mostly came from Bekasi with an average number of visits 1 time and 1-hour length of visit. The reason for their visit were the closeness of the location and to learn crocodiles. The zoo visitors mostly came from Jakarta with an average number of visits more than 3 times and 6 hours length of visits. Respondents visited the zoo because of low cost and recreation. Visitors of the zoo provided positive review for several aspects in the zoo, while visitors in crocodile park gave positive review only on physical condition of crocodiles.

Brackhane, S., Webb, G., Xavier, F.M.E., Trindade, J., Gusmao, M. and Pechacek, P. (2019). Crocodile management in Timor-Leste: Drawing upon traditional ecological knowledge and cultural beliefs. Human Dimensions of Wildlife (https://doi.org/10.1080/10871209.2019.1614240).

Abstract: Cultural beliefs based on Timor-Leste´s creation myth "Lafaek Diak - The Good Crocodile" are anchored in the East Timorese traditional belief system lulik and involve worship of the widely distributed, but dangerous, saltwater crocodile (*Crocodylus porosus*). The wild saltwater crocodile population and rate of fatal attacks on people are both increasing due to conservation action. More innovative management is needed to reduce the frequency of attacks, but reverence for crocodiles constrains the management options available. We used semi-structured interviews with Timorese stakeholders (25 local authorities, 10 national experts, 15 citizens) to understand the cultural beliefs and traditional ecological knowledge underlying human-crocodile interactions, and conflict (HCC) in Timor-Leste. Interviewees knew this species was a risk (respect, fear) and its population was expanding, and had culturally determined beliefs (ceremonies, rituals) that included differentiating between local "ancestor" crocodiles and invasive "troublemakers." Cost-effective management could integrate stakeholder groups, especially traditional elders and local knowledge holders.

Kwak, M.L., Foo, M., Pocklington, K., Hsu, C.-D., Cheong, W., How, C.B., Shunari, M., Tahir, M.G. (2019). Tick-crocodilian interactions: a review, with the first record of tick (Acari: Ixodidae) infestation in the saltwater crocodile (*Crocodylus porosus*), and a concise host-parasite index. Experimental and Applied Acarology 78(1): 127-132.

Abstract: Interactions between ticks and crocodilians (crocodiles, alligators, caiman, and gharials) are poorly studied but may have significant bearing on the ecology and health of these reptiles. The first record of tick infestation of the saltwater crocodile (*Crocodylus porosus*) is reported along with the first case of infestation by *Amblyomma cordiferum* on Cuvier's dwarf caiman (*Paleosuchus palpebrosus*). A review is also provided of tick-crocodilian interactions with a concise host-parasite index.

Kundanati, L., D'Incau, M., Bernard, M., Scardi, P. and Pugno, N.M. (2019). A comparative study of the mechanical properties of a dinosaur and crocodile fossil teeth. Journal of the Mechanical Behavior of Biomedical Materials 97: 365-374.

Abstract: Vertebrate teeth are complex structures adapted in terms of shape and structure to serve a variety of functions like biting and grinding. Thus, examining the morphology, composition and mechanical properties of the teeth can aid in providing insights into the feeding behaviour of extinct species. We here provide the first mechanical characterisation of teeth in a spinosaurid dinosaur, *Suchomimus tenerensis*, and a pholidosaurid crocodylomorph, *Sarcosuchus imperator*. Our results show that both species have similar macrostructure of enamel, dental and interfacial layers, and similar composition, the main constituent being fluorapatite. Microindentation tests show that *Suchomimus* teeth have lower elastic modulus and hardness, as compared to *Sarchosuchus*. On the contrary, *Sarcosuchus* teeth have lower toughness. Nanoindentation showed the existence of mechanical gradients from dentin to enamel in *Suchomimus* and, less prominently, in *Sarcosuchus*. This was also supported by wear tests showing that in *Suchomimus* the dentin region is more wear-prone than the enamel region. With still scarce information available on the dietary regimes in extinct species, the analysis of micro and nano-mechanical properties of fossils teeth might be a help in targeting specific biological questions. However, much is still unknown concerning the changes underwent by organic material during diagenesis making at present impossible to definitely conclude if the differences in the mechanical properties of *Suchomimus* and *Sarchosuchus* here retrieved imply that the two species adopted different strategies when dealing with food processing or are the result of disparate taphonomic histories.

Tucker, L., Favreau, J., Itambu, M., Larter, F., Mollel, N., Mwambwiga, A., Patalano, R., Roberts, P., Soto, M. and Mercader, J. (2019). Initial assessment of bioavailable strontium at Oldupai Gorge, Tanzania: Potential for early mobility studies. OSF Preprints (doi: 10.31219/osf.io/ft38y).

Abstract: Strontium isotope analysis is a useful tool for tracing mobility and migration in past populations. For it to be employed, the 87Sr/86Sr values of the landscape must be well-understood. Bioavailable strontium is a combination of geological and atmospheric strontium available for use by plants and animals. In this study we begin mapping bioavailable strontium values around the Oldupai Gorge region so that this method may be utilized on archaeological hominins and animals in the future. We analyzed three plants from 33 localities across volcanic and metamorphic bedrock, including the regional drainage sump, Olbalbal. We found that bioavailable strontium in the region is homogeneous overall, with trends towards increasing values to the north and northeast and in Olbalbal. There was no difference between 87Sr/86Sr values of metamorphic and volcanic areas. Migrants from outside the study area with different isotopic values will be easily identifiable from the local residents. As a proof of concept, we analyzed 7 animal teeth (hippopotamus, crocodile, and equid) from Engaji Nanyori, a Bed III and IV site at Oldupai Gorge. We found that enamel and dentine which had been acetic acid treated to remove diagenetic strontium were significantly different from one another. All animals had higher 87Sr/86Sr values than the plant values, suggesting that modern and ancient bioavailable strontium values may have been different, likely due to environmental differences.

Fermino, B.R., Paiva, F., Viola, L.B., Rodrigues, C.M.F., Garcia, H.A., Campaner, M., Takata, C.S.A., Sheferaw, D., Kisakye, J.J., Kato, A., Jared, A.A.G.S., Teixeira, M.M.G. and Camargo, E.P. (2019). Shared species of crocodilian trypanosomes carried by tabanid flies in Africa and South America, including the description of a new species from caimans, *Trypanosoma kaiowa* n. sp. Parasites Vectors 12: 225.

Abstract: The genus *Trypanosoma* Gruby, 1843 is constituted by terrestrial and aquatic phylogenetic lineages both harboring understudied trypanosomes from reptiles including an increasing diversity of crocodilian trypanosomes. *Trypanosoma clandestinus* Teixeira & Camargo, 2016 of the aquatic lineage is transmitted by leeches to caimans. *Trypanosoma grayi* Novy, 1906 of the terrestrial lineage is transmitted by tsetse flies to crocodiles in Africa, but the vectors of Neotropical caiman trypanosomes nested in this lineage remain unknown. Our phylogenetic analyses uncovered crocodilian trypanosomes in tabanids from South America and Africa, and trypanosomes other than *T. grayi* in tsetse flies. All trypanosomes found in tabanids clustered in the crocodilian clade (terrestrial lineage) forming six clades: Grayi (African trypanosomes from crocodiles and tsetse flies); Ralphi (trypanosomes from caimans, African and Brazilian tabanids and tsetse flies); Terena (caimans); Cay03 (caimans and Brazilian tabanids); and two new clades, Tab01 (Brazilian tabanid and tsetse flies) and Kaiowa. The clade Kaiowa comprises *Trypanosoma kaiowa* n. sp. and trypanosomes from African and Brazilian tabanids, caimans, tsetse flies and the African dwarf crocodile. *Trypanosoma kaiowa* n. sp. heavily colonises tabanid guts and differs remarkably in morphology from other caiman trypanosomes. This species multiplied predominantly as promastigotes on log-phase cultures showing scarce epimastigotes and exhibited very long flagellates in old cultures. Analyses of growth behavior revealed that insect cells allow the intracellular development of *Trypanosoma kaiowa* n. sp. Prior to this description of *Trypanosoma kaiowa* n. sp., no crocodilian trypanosome parasitic in tabanid flies had been cultured, morphologically examined by light, scanning and transmission microscopy, and phylogenetically compared with other crocodilian trypanosomes. Additionally, trypanosomes thought to be restricted to caimans were identified in Brazilian and African tabanids, tsetse flies and the dwarf crocodile. Similar repertoires of trypanosomes found in South American caimans, African crocodiles and tabanids from both continents support the recent diversification of these transcontinental trypanosomes. Our findings are consistent with trypanosome host-switching likely mediated by tabanid flies between caimans and transoceanic migrant crocodiles co-inhabiting South American wetlands at the Miocene.

Ngo-Son, A. and Katekaew, S. (2019). Purification and characterization of angiotensin converting enzyme-inhibitory derived from crocodile blood hydrolysates. Food Science and Technology (http://dx.doi.org/10.1590/fst.08318).

Abstract Various enzyme types were used to hydrolyze crocodile blood peptides showing an Angiotensin I-converting enzyme (ACE) inhibitory activity. Alcalase hydrolysates (ALH) and Protease G6 hydrolysates (PG6H) showed the highest degree of hydrolysis ($P<0.05$). However, PG6H was significantly observed to have an effective ACE-inhibitory (ACE-I) activity (94.23%) with an IC50 of 0.021±0.02 mg/mL. An unbound fraction of PG6H showed the highest ACE-I activity and was then subjected to two steps RP-HPLC process. The potent fractions including RC1 and RC2 exhibiting the highest ACE-I activity (88.33 & 84.54%, respectively) were identified using LC-MS/MS. Two novel ACE-inhibitory peptides were identified as GVAAN (431.25 Da) and LHALLL (679.52 Da), and characterized by GRAVY were 60 and 83%, respectively. The crocodile blood hydrolysate obtained by Protease G6 could serve as a source of ACE-inhibitory activity for physiological benefits.

Williams, C. (2019). Anaesthesia and Analgesia in Reptiles and Amphibians: Physiological Implications. PhD thesis, Aarhus University, Aarhus, Denmark.

Abstract:: Veterinary anaesthesia has developed markedly in the last half century. These advances can now be brought to bear in 'cold-blooded' animals, both in practice, and in the field of comparative physiology, where reptiles and amphibians have been long studied due to their eclectic and fascinating cardiovascular and respiratory systems. These two systems both provide the means of administration of anaesthetics, via the blood or inhaled gases, and are themselves profoundly influenced by anaesthesia. The resulting shifting relationships between physiology and anaesthesia are the subject of this thesis. There are several components of successful anaesthesia, which, depending on the goal of the anaesthetic, can include: loss of consciousness and memory, loss of reflexes (both of the muscles, and the internal regulatory systems) and the dampening of pain. These attributes are explored in amphibians and reptiles throughout the studies included in this thesis. Chapter I reviews current anaesthesia in reptiles and amphibians, from a physiologist's point of view. Chapter II provides a concise overview of pain and pain relief (analgesia) in non-mammals. Chapter III gives an example of the cross-over between a drug normally used as pain relief - lidocaine -with sedation, due to the circulatory physiology of the frog. Chapter IV discusses the effects of common drugs used to induce anaesthesia (propofol and alfaxalone) on the circulatory and respiratory system of the frog. Chapter V and VI discuss using alfaxalone to induce sedation and anaesthesia in pythons, with effects on their respiratory and cardiovascular system, and profoundly influenced in its action by the circulatory system of snakes. Inhaled anaesthesia is explored in Chapter VII in tortoises, using MRI to virtually dissect the heart to measure blood flow under different conditions, and reports the effect this blood flow change has on the effective dose of gas anaesthesia. The heart of the tortoise is probed further in Chapter VIII where its efficiency of pumping is determined under anaesthesia. The findings of Chapters VII and VIII prompted a theoretical assessment of the effects of reptile physiology on inhaled anaesthesia – presented in Chapter IX. Recovery of physiology from multi-model anaesthesia is explored in Chapters X for Nile crocodiles. In summary, these data explore the varied effects of different anaesthetics on an organism's physiology, and the effects of the diverse and uniquely adaptable cardiovascular system of reptiles and amphibians on anaesthetics. We also expose the particular effects of some drugs used as pain killers on the cardiovascular and respiratory systems.

Kumar, A., Kushwaha, S. and Namdev, A. (2019). Mugger (*Crocodylus palustris*) sightings in water bodies of Bundelkhand Region, India. International Journal of Zoology Studies 4(2): 63-67.

Abstract: The avifaunal diversity of Bundelkhand Region is being studied since 2008. However, the Herpetofauna is poorly studied and lacks even the baseline data for most of the species. There has been no survey for aquatic reptiles in Bundelkhand region. During the research work and various surveys undertaken from 2015-2018, occurrence of Vulnerable Marsh Crocodile (*Crocodylus palustris*) was recorded at several sites including rivers, reservoirs and lakes. The observations show the possibility of a promising population of mugger in Bundelkhand region, particularly the river Betwa. *Crocodylus palustris* was sighted in Jhansi, Lalitpur, Shivpuri and Tikamgarh districts. However, secondary data reveals a population of 400-500 crocodiles in River Betwa alone. For long-term conservation of this species, there should be scientific annual counting and monitoring of crocodile populations with the involvement of local people, and create awareness for this Vulnerable according to IUCN and Schedule-I species under the Wildlife Protection Act, 1972.

Specioza, M. (2018). The Potential for Development of Farm Tourism in Uganda: A Case Study of Buwama Crocodile Farm in Mpigi District. Bachelor of Tourism thesis, Makerere University, Uganda.

Abstract: The study was carried out analyze the tourism potentials of Buwama crocodile farm in Mpigi district. It was guided by objectives; to identify tourism resources at Buwama crocodile farm, to examine the tourism opportunities that can be developed at Buwama crocodile farm and to establish the challenges associated with at Buwama crocodile farm. A semi structured questionnaire was administered to 60 randomly selected respondents and structured interviews were held with farm managers and local leaders who were selected purposively. Findings were later analyzed with the aid of a computer package for social sciences to attach the meaning. The study established that Buwama crocodile farm has various tourism attractions such as crocodile, Lake Victoria, Kitebo pier, accommodation facilities like bandas among others. The study too revealed the various tourism opportunities available at Buwama crocodile farm that have not yet developed and identified are; boat cruise at the lake, bird watching, picnic viewing and rapidly expanding infrastructures most especially accommodation. Lastly the study established challenges associated with the farms which among others include still competition, limited markets, lack of knowledge about crocodile farming and diseases which affect the health of the crocodiles. Based on these findings , the study recommends the need to develop more tourism products in and around Buwama crocodile farm to increase on the number of tourists visiting the farm , Improving the management of crocodile farming aiming at producing good quality products from the farm, and establishing pattern ships with other countries, are considered essential in providing crocodile market and a call for farm management to partner with the association of Uganda Tourism Board and tour companies in increasing visibility.

Setyowati, E., Ngabekti, S. and Priyono, B. (2019). Konservasi Buaya Muara di Taman Margasatwa Semarang. Life Science Journal of Biology 8(1): 34-40.

Abstract: Estuary crocodile (*Crocodylus porosus*) is one of the fauna that is protected by Indonesian law because of its high economic value. Publications regarding the success of estuarine crocodile conservation are still small. Efforts can be made to prevent the extinction of estuarine crocodiles through conservation. Semarang Wildlife Park is an *ex-situ* conservation institution that has succeeded in breeding estuarine crocodiles. This study aims to examine the methods of estuarine crocodile conservation, factors in conservation methods, and the success rate of estuarine crocodile conservation in Semarang Wildlife Park. The research methods used were observation, interviews, and documentation. The research data were analyzed by quantitative descriptive analysis. The results showed that the method of estuarine crocodile conservation in Semarang Wildlife Park took the form of breeding activities consisting of management of housing, feed, health, and breeding. The factors that influence conservation success are cage, feed, and weather. The level of success of estuarine crocodile conservation in Semarang Wildlife Park seen from the aspect of DTT 55.4% and MR 29% with criteria quite successful. Suggestions that can be conveyed are Need to do further research on measuring the temperature and humidity of the soil used as nest of estuarine crocodile eggs in the aspect of egg hatching that affect the success of conservation and more intensive management of estuarine crocodile breeding activities in Semarang Wildlife Park for successful conservation.

Nöthling, J.O., Nöthling, J.A. and Myburgh, J.G. (2019). A model by which to estimate the volume of Nile crocodile eggs after they have hatched - original research. Suid-Afrikaanse Tydskrif vir Natuurwetenskap en Tegnologie 38(1) (https://hdl.handle.net/10520/EJC-16140f9371).

Abstract: The value of their leather stimulates commercial farming with several crocodilian species. The survival and growth of crocodile hatchlings depends on their birth mass. There exists a positive relationship between the hatchling mass and egg size of several crocodilian species. The size of crocodilian eggs is often not measured before hatching. The aim of this study was to create a model whereby the volume of individual Nile crocodile eggs can be estimated after they have hatched and the shell been broken, so that the relationship between egg volume and hatchling mass can be studied on an individual basis without the size of the eggs having been measured prior to hatching. Infertile eggs were photographed in side view, with one pole towards the bottom and the other towards the top and a scale in the focal plane. Their volumes were measured by water displacement (displacement volume). A custom-written computer program was used to measure the photo images. The program turned the image of the egg upright and the position of the polar axis was determined without considering the position of the upper pole. Various transverse diameters (perpendicular to the polar axis) were measured, and the volume of the egg calculated by integrating the function describing the horizon of the egg on the polar axis (calculated volume). The best models for estimating the calculated volume were determined by using information limited to various distances from the bottom pole of the egg's image towards its upper pole, and for eggs of different polarity. The models were then used to estimate the volumes of 138 eggs of which 15%, 20%, 25% and 30% of the image of each egg were masked from the upper pole towards the bottom pole. Volumes of 60-135 ml derived from analysis of the masked photographic images of eggs permitted estimation of the eggs' volumes to within 4.57 ml of their actual volumes with 95% confidence. This study makes it possible to estimate the volume of eggs from the shells of hatched eggs and identify a variation larger than 7.72% in the birth mass of Nile crocodile hatchlings from eggs with an estimated volume of 60 ml, with the precision increasing to identify a variation larger than 3.40% for hatchlings from eggs with an estimated volume of 135 ml with 95% confidence.

Moosmueller, K. and Wilhelm, B. (2019). Skeletal adaptations for an aquatic lifestyle in the tail of reptiles. 2019 Student Research Showcase, SUNY Digital Repository.

Abstract: Many reptiles are adapted for aquatic habitats. Crocodilians (such as the American alligator *Alligator mississippiensis*), the marine iguana (*Amblyrhynchus cristatus*) and Philippine Sailfin lizard (*Hydrosaurus pustulatus*) are all examples of reptiles that can be found in aquatic environments. We hypothesize that organisms adapted for an aquatic lifestyle should have anatomical adaptations related to that lifestyle. The aquatic reptiles named above will be compared to the green iguana (*Iguana iguana*) that primarily inhabits terrestrial environments. We will examine the skeletal and muscular anatomy of these organisms to determine the anatomical adaptations, if any, that are present in relation to an aquatic lifestyle. Although these adaptations may be found throughout the body, our research will focus on the tail, as the tail is the primary structure used for locomotion in many aquatic organisms.

Bertin, T. (2018). Dynamics and Evolution of Dental Replacement in Amniota. PhD thesis, Claude Bernard University, Lyon, France.

Abstract: Dental replacement consists in the formation of a new tooth which will come take the place of a former tooth, allowing for a renewal of the dental tissues as well as their environment (periodontium). To understand the evolution and the dynamics of tooth replacement, it is necessary to search for a relevant biological model. Because of the strong link between the replacement of teeth and periodontal tissues, I searched the diversity and evolutionary history of tooth replacement, attachment and implantation in extant and fossil amniotes. This work presented two objectives: clarify the terminology associated with replacement, implantation and attachment and review the current knowledges and hypothesis concerning the diversity and the evolution of the three features. In a second part, I studied continuous tooth replacement in archosaurians which present a continuous tooth replacement. First I investigated the teeth of the last groups of toothed-birds. To study the developmental mechanisms of continuous replacement, I studied the mechanisms

of dental replacement in the Nile crocodile, through X-ray MicroCT. Nile crocodile's embryos present two type of teeth. The study of the genetic expression of the Notch pathway revealed that surface teeth and submerged teeth present a very similar development, and the main difference is the interruption of the development in the earliest. The Notch pathway also seems to be involved in tooth replacement in this species. In a third part, I studied one alternative to tooth replacement in group which lost the continuous tooth replacement. To do so, I studied the common warthog and the different adaptations of its dentition to highly abrasive diet. I mainly focused of the process of mesial drift, and all the physiological processes associated with drift to understand and recognize this phenomenon.

Martinez, J., Vega, K., Kleine, K. and Bravo, C. (2019). Is the caudofemoralis longus muscle the primary driver of crocodilian propulsion? OSR Journal of Student Research 5: Article 74.

Abstract: The caudofemoralis longus (CFL) muscle is assumed to play an important role in crocodilian terrestrial locomotion. Earlier electromyographic studies of the American alligator hind limb musculature found that the CFL muscle is active during the stance phase, and thus acts as the primary retractor and medial rotator of the thigh. Our project uses a surgical approach to test this hypothesis in 12 alligator hatchlings. We performed unilateral tenotomy (severing the distal tendons) on the right CFL muscle to render it nonfunctional, while the contralateral (left) side was shamoperated. Animals were allowed to recover and grow for three months, at which point surface markers were placed on their hind limb joints (ankle, knee, hip). We filmed their locomotor behaviour at 1000Hz using three high-speed video cameras to allow for track markers and reconstruct hind limb posture kinematics in 3D. Using ProAnalyst software, we analysed differences joint angles, as well as hip height and stride length at constant-speed strides during level walking. Ground reaction forces by the hind foot were measured using a force plate flush with the walkway surface and analysed with the help of IGOR. Preliminary data suggest no significant differences in hind limb posture between the tenotomised and control sides. This leads us to suggest that the CFL muscle is not a primary driver of crocodilian terrestrial locomotion.

Felbinger, K. (2019) Pulmonary bypass shunt reduces oxidative stress in the American alligator. OSR Journal of Student Research 5: Article 56.

Abstract: There have been several hypotheses proposed discussing the evolutionary preservation of cardiac shunting among some of the vertebrates; specifically the right-to-left (R-L) pulmonary bypass shunt seen in reptiles. We hypothesized that the R-L shunt mitigates the amount of oxidative stress imposed upon the tissues of vertebrates exposed to atmospheric hyperoxia. In order to test this hypothesis, we eliminated the R-L shunting ability in juvenile American alligators (*Alligator mississippiensis*) by surgical ligation of the left aorta (LAo), effectively preventing their circulatory system to no longer function in-parallel but in-series. Experimental animals (no R-L shunt; n= 8) and shamoperated controls (shunt intact; n= 8) were housed under normoxia (21% O_2) and hyperoxia (35% O_2) conditions at 30°C for 25 days. Whole blood and plasma samples collected after each exposure were assayed for lipid peroxidation and antioxidant activity. We found significantly higher (+13%) malondialdehyde concentrations in response to hyperoxia in experimental animals, and no differences in catalase concentration between treatment groups. This suggests alligators without shunting ability suffered greater oxidative damage than those who maintained the shunt, and were also unable to mount a sufficient cellular antioxidant defenses to protect against the influx in reactive oxygen species. We suggest the pulmonary bypass shunt, by admixture of deoxygenated and oxygenated blood, reduces blood oxygen tension and limits oxidative stress upon the systemic tissues. Palaeoatmospheric oxygen fluctuations would have had limited effect on contemporary vertebrate taxa with in-parallel circulation. Evolution of in-series circulation in ancestors of mammals and bird must have necessitated upregulation of antioxidant expression.

Handy, S., Ceja, M. and Arnette, J. (2019). The potential role of osteoderms during thermoregulation in the American alligator. OSR Journal of Student Research 5: Article 264.

Abstract: Osteoderms in crocodilians are known to function in mechanical protection, locomotor support, and acid-base regulation. With a rich vascular supply, osteoderms are also thought to play an active role in crocodilian thermoregulation, allowing the animal to absorb or dissipate heat faster than has non-ossified dermis. We tested this hypothesis by monitoring superficial and deep temperatures of juveniles of the American alligator (body mass 0.3-30 kg) during warming and cooling between 15 and 30°C. We recorded skin surface temperatures with an infrared camera, and core temperature with a cloacal thermocouple. We controlled for cutaneous perfusion by running the experiments first on live animals and then on their carcasses. We found, unsurprisingly, that animal size has a significant negative effect on rate of heat exchange. Further, warming (to 30°C) occurred significantly faster in live animals than carcasses, but differences in cooling (to 15°C) were not appreciable. Scales with osteoderms (in the cervical and dorsal regions) showed small (<2°C) differences in temperature profile from neighbouring scales without dermal bone. These temperature differences were most pronounced at the start of each experiment, and disappeared with each experiment duration. Notably, these temperature differences were not consistent between anatomic regions within an animal, or between animals (i.e., scales with osteoderms sometimes showed higher, sometimes lower surface temperature). Importantly, these temperature differences were similar in carcasses. This suggests that heat exchange through the crocodilian skin is dependent more on thermal characteristics of individual scales, and their anatomic location, than on vascular perfusion of underlying tissue, with or without osteoderms.

Marcaida, A.J.B., Urabe, M., Briones, J.C.A., Diesmos, M.L.L., Tellez, M. and Diesmos, A.C. (2019). The curious case of the endemic freshwater crocodile *Crocodylus mindorensis* as incidental host of marine fish acanthocephalan. Parasitology International (https://doi.org/10.1016/j.parint.2019.101940).

Abstract: We performed the first host-parasite survey of the Philippine crocodile, *Crocodylus mindorensis*, a critically endangered species for which ecological information is lacking. We collected by gastric lavage samples of the stomach contents of crocodiles (n= 10) residing at the Palawan Wildlife Rescue and Conservation Center in Puerto Princesa, Palawan, Philippines. The only parasite detected was an acanthocephalan, which was identified as *Neorhadinorhynchus nudus* (n= 68), a parasite typically found in the marine fish species consumed by three crocodile individuals. Given the known hosts of *N. nudus*, its parasitism of *C. mindorensis* in captivity is likely established by consumption of marine fish. Our findings have implications for the conservation management of *C. mindorensis*, particularly in terms of preventing introduction of parasites that could lead to development of infectious disease or alter the fitness of captive animals.

Schlosberg, M. (2019). Bloodthirst. The Lifted Brow 42: 43-48.

Abstract: In February of 1985, ecofeminist philosopher Val Plumwood was attacked by a saltwater crocodile. She was in a red plastic canoe, in the part of the river she was told not to go to. She tried to jump from the canoe into a tree to escape the crocodile, but the crocodile jumped too. It death-rolled her three times in the water before she managed to escape and crawl to a place where a ranger found her.

Barrow, D. and Halford, A.R. (2019). A modified biopsy needle with pole for repeatable tissue extraction from free-ranging crocodiles. Wildlife Society Bulletin (doi: 10.1002/wsb.969).

Abstract: Biopsy sampling is a powerful tool for furthering our understanding of animal populations. Knowledge of diets and trophic energy flows, genetic structure and connectivity between populations, and uptake of environmental contaminants can all be elucidated through analysis of animal tissues, which is particularly useful for animals that are elusive and difficult to observe. Crocodylians are an aquatic group for which biopsy sampling is an appropriate tool; however, sample collection usually requires undertaking the arduous and dangerous process of capturing individual crocodiles. We describe a biopsy system that employs a modified version of a standard biopsy needle and pole kit to consistently extract crocodile tissue with greatly reduced effort and increased safety. This system takes advantage of the behavioral trait of crocodiles to "freeze" under the glare of a high-powered spotlight, enabling an approach to within a few meters. We field-tested the system in 2 remote river systems in northwestern Australia, during July-August 2015, collecting tissue samples from 69 crocodiles (*Crocodylus porosus*; size range= 0.9-4.4 m total length) with approximately 95% success. The pole biopsy system increases sample collection efficiency by removing the need to handle individual crocodiles. Moreover, this decreases stress on the crocodile population and significantly reduces the number of field crew required.

Alderman, S.L., Crossley II, D.A., Elsey, R.M. and Gillis, T.E. (2019). Hypoxia-induced reprogramming of the cardiac phenotype in American alligators (*Alligator mississippiensis*) revealed by quantitative proteomics. Scientific Reports 9: 8592 (2019)

Abstract: Hypoxic exposure during development can have a profound influence on offspring physiology, including cardiac dysfunction, yet many reptile embryos naturally experience periods of hypoxia in buried nests. American alligators experimentally exposed to developmental hypoxia demonstrate morphological and functional changes to the heart that persist into later life stages; however, the molecular bases of these changes remain unknown. We tested if targeted and persistent changes in steady-state protein expression underlie this hypoxic heart phenotype, using isobaric tags for relative and absolute quantitation (iTRAQ) proteomics. Alligator eggs were reared under normoxia or 10% hypoxia, then either sampled (embryo) or returned to normoxia for 2 years (juvenile). Three salient findings emerge from the integrated analysis of the 145 differentially expressed proteins in hypoxia-reared animals: (1) significant protein-protein interaction networks were identified only in up-regulated proteins, indicating that the effects of developmental hypoxia are stimulatory and directed; (2) the up-regulated proteins substantially enriched processes related to protein turnover, cellular organization, and metabolic pathways, supporting increased resource allocation towards building and maintaining a higher functioning heart; and (3) the juvenile cardiac proteome retained many of the signature changes observed in embryonic hearts, supporting long-term reprogramming of cardiac myocytes induced by hypoxia during critical periods of development.

Valverde, A., Madrigal-Valverde, M., Castro-Morales, O., Gadea-Rivas, A., Johnston, S. and Soler, C. (2019). Kinematic and head morphometric characterisation of spermatozoa from the Brown Caiman (*Caiman crocodilus fuscus*). Animal Reproduction Science 207: 9-20.

Abstract: The development of analytical methods for the evaluation of crocodilian semen is an important component for the assessment of male breeding soundness and the development of assisted breeding technology in this taxon. Computer-Assisted Semen Analysis (CASA) technology is becoming an increasingly common technique in seminal evaluations for animals but there has been no application of this technique for reptilian spermatozoa. The aim of this study was to analyse sperm kinematic and morphometric variables in *Caiman crocodilus fuscus* semen samples and to determine whether there were sperm subpopulations. Four ejaculates from four sexually mature captive caimans were used for this study. A CASA-Mot and CASA-Morph system was used with an image acquisition rate of 50 Hz for 2 s of capture. The ISAS®D4C20 counting chambers were used and spermatozoa incubated at 25°C. Total and progressive motilities did not differ among animals ($P>0.05$). There was a significant animal effect in the model with respect to sperm morphometry, and kinematic indices including linearity (LIN) and straightness (STR) ($P<0.05$). Results for principal component (PC) analysis indicated variables were grouped into four components: PC1 related to velocity, PC2 to progressivity, PC3 to oscillation and PC4 to sperm path cross-linking. Subpopulation (SP) structure analysis indicated there were four groups, namely, rapid non-progressive (SP1), slow non-progressive (SP2), rapid progressive (SP3) and medium progressive (SP4), representing 14.5%, 45.4%, 18.7%, and 21.4% respectively. Findings in the present study indicate the importance of continuing development of reliable protocols regarding the standardisation of computer-based semen analyses in reptilian species.

Lee, Y.-N., Lee, H.-J., Kobayashi, Y., Paulina-Carabajal, A., Barsbold, R., Fiorillo, A.R. and Tsogtbaatar, K. (2019). Unusual locomotion behaviour preserved within a crocodyliform trackway from the Upper Cretaceous Bayanshiree Formation of Mongolia and its palaeobiological implications. Palaeogeography, Palaeoclimatology, Palaeoecology (https://doi.org/10.1016/j.palaeo.2019.109239).

Abstract: Crocodyliform tracks are reported from the Upper Cretaceous (?Cenomanian-Santonian) Bayanshiree Formation in southeastern Mongolia. Ten tracks are preserved as natural casts, forming a trackway with a quadrupedal gait pattern with a tail trail. All tracks are short and wide, and dominated by toe traces without plantar impressions. Pes tracks are characterized by four deep claw impressions and push-back marks behind them. Manus tracks have shallow claw marks and long, sub-parallel scratch marks behind. The preferential association of the scratch marks with only the distal digit impressions and irregular pattern of footfalls suggests that this trackway was made by a bottom walking and punting crocodyliform under water. This trackway represents the first crocodyliform "swim tracks" in the Late Cretaceous of Asia and the first evidence for punting behaviour of a fossil crocodyliform. It shows that crocodylians already adopted a very similar behaviour of bottom walking to extant crocodylians in the Cretaceous. The "swim tracks" of crocodyliforms can be divided into two categories such as bottom walking tracks with punting for moving somewhat more quickly and subaqueous walking tracks without punting to be associated with slower underwater speeds.

Polák, J., Rádlová, S., Janovcová, M., Flegr, J., Landová, E. and Frynta, D. (2019). Scary and nasty beasts: Self-reported fear and disgust of common phobic animals. British Journal of Psychology (https://doi.org/10.1111/bjop.12409).

Abstract: Animal phobias are one of the most prevalent mental disorders. We analysed how fear and disgust, two emotions involved in their onset and maintenance, are elicited by common phobic animals. In an online survey, the subjects rated 25 animal images according to elicited fear and disgust. Additionally, they completed four psychometrics, the Fear Survey Schedule II (FSS), Disgust Scale – Revised (DS-R), Snake Questionnaire (SNAQ), and Spider Questionnaire (SPQ). Based on a redundancy analysis, fear and disgust image ratings could be described by two axes, one reflecting a general negative perception of animals associated with higher FSS and DS-R scores and the second one describing a specific aversion to snakes and spiders associated with higher SNAQ and SPQ scores. The animals can be separated into five distinct clusters: (1) non-slimy invertebrates; (2) snakes; (3) mice, rats, and bats; (4) human endo- and exoparasites (intestinal helminths and louse); and (5) farm/pet

animals. However, only snakes, spiders, and parasites evoke intense fear and disgust in the non-clinical population. In conclusion, rating animal images according to fear and disgust can be an alternative and reliable method to standard scales. Moreover, tendencies to overgeneralize irrational fears onto other harmless species from the same category can be used for quick animal phobia detection.

Sues, H.-D. (2019). The Rise of Reptiles - 320 Million Years of Evolution. John Hopkins University Press: Baltimore, USA.

Lujan, À.H., Chroust, M., Cernansky, A., Fortuny, J., Mazuch, M. and Ivanov, M. (2019). First record of *Diplocynodon ratelii* Pomel, 1847 from the early Miocene site of Tušimice (Most Basin, Northwest Bohemia, Czech Republic). Comptes Rendus Palevol. (https://doi.org/10.1016/j.crpv.2019.04.002).

Abstract: The early Miocene deposits of Bohemia (Czech Republic) contain numerous fragmentary crocodylian remains. Despite this abundance, a detailed taxonomical assignment of these remains was impossible due to the absence of diagnostic cranial elements. Here, we report two partially preserved skulls together with some osteoderms and a partially preserved vertebra from the Tušimice site (MN3, Most Basin, Northwest Bohemia). Though the specimens were from Bohemia, the exact placement of this site was lost during the last century. Our results confirm that the coal from the reported specimens is consistent with the Tušimice site. Based on the detailed cranial description of the new material, the crocodylian remains from the above-mentioned locality can be referred to the extinct alligatoroid *Diplocynodon ratelii* with confidence. Our data extend the known spatial distribution of this taxon to Central Europe.

Caut, S., Francois, V., Bacques, M., Guiral, D., Lemaire, J., Lepoint, G., Marquis, O. and Sturaro, N. (2019). The dark side of the black caiman: Shedding light on species dietary ecology and movement in Agami Pond, French Guiana. PLoS ONE 14(6): e0217239.

Abstract: The black caiman is one of the largest neotropical top predators, which means that it could play a structuring role within swamp ecosystems. However, because of the difficulties inherent to studying black caimans, data are sorely lacking on many aspects of their general biology, natural history, and ecology, especially in French Guiana. We conducted a detailed study of the Agami Pond black caiman population using a multidisciplinary approach. The aim was to better understand the species' dietary ecology and movements in the pond, and thus its functional role in pond system. We gathered natural history data, tracked caiman movements using satellite transmitters, and characterized feeding ecology via stable isotope analysis. Our study was carried out over three sampling periods and spanned both wet and dry seasons, which differ in their hydrological and ecological conditions. Our results show that black caiman abundance and age demographics differed between seasons in Agami Pond. In the dry season, Agami Pond is one of the only areas within the marsh to hold water. It thus contains large quantities of different fish species, which form the basis of the black caiman's diet. Caiman body size, a proxy for age class, was around 1.5 meters. During the wet season, which corresponds to the breeding period for migratory birds (eg Agami herons), adult black caimans are present in Agami Pond. Adults were most abundant in the inundated forest. There, most individuals measured up to 2 metres. They also exhibited a particular "predatory" behavior near bird nests, preying on fallen chicks and adults. Juveniles and subadults were present during both seasons in the pond's open waters. These behavioral observations were backed up by stable isotope analysis, which revealed ontogenetic variation in the caiman's isotopic values. This isotopic variation reflected variation in diet that likely reduced intraspecific competition between adults and young. The telemetry and microchip data show that different age classes had different movement patterns and that seasonal variation in the pond may influence caiman prey availability and reproductive behavior. The new information gathered should help predict this species' responses to potential ecosystem disturbance (eg water pollution, habitat destruction) and inform the development of an effective conservation plan that involves locals and wildlife officials.

Pan, T., Wang, H., Duan, S., Ali, I., Yan, P., Cai, R., Wang, M., Zhang, J., Zhang, H., Zhang, B. and Wu, X. (2019). Historical population decline and habitat loss in a critically endangered species, the Chinese alligator (*Alligator sinensis*). Global Ecology and Conservation (https://doi.org/10.1016/j.gecco.2019.e00692).

Abstract: Habitat loss and degradation are among the leading causes of local extinctions, so it is crucially important to preserve and restore the remaining critical habitat increasingly critical to conserve biodiversity. However, mechanisms driving species extinction often begin with habitat loss and seldom are well understood, which is greatly limits our ability to mitigate their impacts. The Chinese alligator (*Alligator sinensis*) is a critically endangered crocodilian, which is narrowly distributed in very small six regions of Anhui Province, China. In the present study, we used 9 nuclear microsatellite loci genotyped across the taxon's distribution area to investigate genetic variation and population demography in *A. sinensis*. The Chinese alligator showed unusually low levels of genetic diversity (Na, 5.44; Ne, 1.97; He, 0.47) based on 793 individuals. Msvar analyses found recent signals of population decline reflecting a bottleneck (an approximately 9-fold decrease) about 25,000 years ago. Ecological niche modelling has shown that the habitat area has declined (about 8-15 fold) for *A. sinensis* when compared with that under different historical climatic conditions. Our results indicated that population decline and habitat loss in critically endangered Chinese Alligators may have acted as intrinsic and extrinsic factors that have impacted the current status of *A. sinensis*. In addition, these two unfavorable factors may have also directly contributed to a reduction in the genetic diversity of *A. sinensis*.

Rekha, H.G. (2019). Development of iconography of Gajendra Moksha with special reference to Hoysala Art. The Research Journal of Social Sciences 10(6): 455-463.

Abstract: Gajendra Moksha (Karivarada or Varadaraja) is a manifestation of Vishnu. Varadaraja means king among boon bestowing and Vishnu is also called because he saved and bestowed boons upon Gajendra. This theme is vividly described in Bagavatha purana, in this theme Vishnu is seated on the back of the flying Garuda, which comes down to earth to protect Gajendra, the elephant from the clutches of the crocodile and there by Gajendra attains moksha from the hands of Vishnu. The present study focus on the development of iconography of Gajendra Moksha with special reference to Hoysala art, here Gajendra Moksha sculptures of Gupta temple at Deogarh, Virupaksha and Mallikarjuna temples at Pattadakallu, and Hoysala sculptures from Halebidu, Koravangala and Marale are taken for study. Variations in the themes of sculptures at Deogarh, Pattadakallu and Hoysala sculptures are accounted.

Figueiredo, S., Rosina, P. and Bachtsevanidou Strantzali, I. (2019). The paleoenvironment of the Papo-Seco Formation (Lower Cretaceous) of Cabo Espichel (Southern Portugal). Area Domeniu, Vol. 8, International Meeting on Paleoclimate: Change and Adaptation.

Abstract: New vertebrate and invertebrate fossilized remains are reported herein from the basal deposits (marls, sands and gravels) of Papo-Seco Formation (Lower Barremian, Lower Cretaceous) Cabo Espichel (Sesimbra, south of Lisbon). Papo-Seco formation lies between Areias do Mastro Formation and Boca do Chapim Formation (Manupella et al., 1999). The very first palaeontological investigations in Papo-Seco Formation took place in the 19th century (Figueiredo et al., 2015, 2016). The geological survey reported dinosaur and crocodile teeth from the Papo-Seco Formation, at

Boca do Chapim (Sauvage, 1898). The studied layers were formed in an environment of shallow-marine features (lagoon, estuary). Initial paleontological inspections produced several vertebrate and invertebrate remains; after thorough examination, we identified bones and teeth of fish, crocodiles, dinosaurs, pterosaurs and turtle shell fragments. The sedimentological analysis and taxon identification suggested an evolution from a closed (estuary) to gradually a more open sea environment (pelagic). Examination of the fossil specimens and sediment sample from a paleoenvironmental perspective, revealed that the basal layer was deposited in a lagoon like or estuarine environment whilst the upper layer in a costal one. The fossilized animal diversity is indicative of the following environments: invertebrate fossils, like Eomiodon Cuneauos indicates brackish environment of estuarine type; Nipponomaia, is a fresh water mollusc of lacustrine floodplain environments and Naticids (Fig. 1 - Left) live on sandy substrates at a great variety of depths depending on the species (Figueiredo *et al*., 2016). From the studied material, one species of fish, that of *Lepidotes*, is generally found in environments such as fresh water lakes and shallow seas and shared its habitat with the crocodiles and turtles found. The remains of tetrapods (Fig. 1 - middle and right, and Fig. 2) suggest the following environments: Turtles: represent semi-aquatic to marine environments; crocodiles: represent semi-aquatic environments; pterosaurs: generally, are found in the littoral zone and dinosaurs: in both terrestrial and the littoral zone. Specifically, *Anteophthalmosuchus* sp. was a semi-aquatic crocodile, its remains are found in areas of open water environments but more broadly in freshwater wetlands and sub-environments such as marshes, swamps and swampy lakes or ponds, streams and rivers. Pterosaurs (Ornithocheiridae and Ctenochasmatoidea) as fish-eating animals for their dietary habits they preferred locations such as near sea and lagoons; Baryonix, for the same reasons, inhabited littoral or fluvial zones, lagoons, and estuarine environments as well (Figueiredo *et al*., 2016). Some sedimentary studies (like the combined clay mineralogical/palynological study, made by Ruffell and Batten, 1990) suggested that the Barremian paleoclimate was dominated by relative aridity, the fauna and features of the studied layers in Papo-Seco Formation, with an estuary, lagoon and sea environments with aquatic or semiaquatic fauna, suggested a humidity paleoclimatic interpretation.

Ligtermoet, E. (2019). People, Place and Practice on the Margins in a Changing Climate: Sustaining Freshwater Customary Harvesting in Coastal Floodplain Country of the Alligator Rivers Region, Northern Territory of Australia. PhD thesis, Australian National University, Canberra, ACT, Australia.

Abstract: Human-environment interactions will be profoundly affected by anthropogenic climate change. Coastal communities, dependent on freshwater ecosystems for their livelihoods and cultural practices, are likely to be seriously impacted by rising sea level. For communities already subject to marginalising forces of remoteness, poverty or the legacies of colonisation, climate change impacts will likely compound existing stressors. The freshwater floodplains of the Alligator Rivers Region in the Northern Territory, spanning Kakadu National Park and part of West Arnhem Land, represent such a place. This area is at risk from sea level rise, particularly saltwater intrusion, while also home to Aboriginal Australians continuing to practice customary or subsistence harvesting based on freshwater resources. In seeking to support sustainable adaptation to climate change in this context, this thesis examines Indigenous people's experiences, in living memory, of responding to past and persisting social-ecological change. A place-based, contextual framing approach was used to examine vulnerability and adaptive capacity. Through semi-structured interviews, trips on country, cultural resource mapping and archival work, contemporary patterns of freshwater resource use and Aboriginal people's perceptions of changes to their freshwater hunting, fishing and gathering activities (collectively termed 'harvesting') were examined. Qualitative models were used to conceptualise factors influencing an individual's ability to engage in freshwater customary harvesting and the determinants shaping adaptive capacity for customary harvesting. The social-ecological drivers of change in freshwater harvesting practices raised by respondents included: existing threats from introduced animals and plants, altered floodplain fire regimes and the 'bust then boom' in saltwater crocodile population following recovery from commercial hunting. These all had implications for sustaining customary harvesting practices including restricting access and the transmission of knowledge. Impacts driven by the introduced cane toad, invasive para grass and saltwater crocodile population change, represent examples of solastalgia, particularly for women's harvesting practices. In addition to environmental conditions, determinants of adaptive capacity of customary harvesting included; mobility on country- particularly supported through on country livelihoods and outstations, social networks facilitating access and knowledge sharing, health and well-being and inter-generational knowledge transmission. Past experience of saltwater intrusion facilitated by feral water buffalo in Kakadu was examined through the lens of social learning, as a historical analogue for future sea level rise. These experiences were shown to influence contemporary perceptions of risk and adaptive preferences for future sea level rise. Customary harvesting was also found to offer unique opportunities to improve remote Indigenous development outcomes across diverse sectors. To build adaptive capacity supporting freshwater customary harvesting practices in this context it will be essential to; understand historical trajectories of social-ecological change, recognise the potential for diversity within groups- including a gendered analysis of adaptive capacity, address existing social-ecological stressors and foster knowledge collaborations for supporting knowledge transmission, the co-production of knowledge and sustaining social networks. Facilitating a social learning environment will be particularly crucial in supporting local autonomy, leadership and experimental learning, and is particularly beneficial in jointly managed protected area contexts. Most importantly, incorporating local Indigenous knowledge, values, perceptions of change and risk into locally-developed adaptation strategies will be essential in developing more culturally relevant and thus sustainable, adaptation pathways.

Shawkey, M.D. and D'Alba, L. (2019). Egg pigmentation probably has an early Archosaurian origin. Nature 570: E43-E45.

Wiemann, J., Yang, T.-R. and Norell, M.A. (2019). Reply to: Egg pigmentation probably has an Archosaurian origin. Nature 570: E46-E50.

Patabandi, K.P.L.N. (2019). The changes in amphibians and reptile species living in the tank environment effect from the renovation of small tanks in Dry Zone in Sri Lanka (Case Study In Galgamuwa Division in Kurunegala). International Journal of Liberal Arts and Social Science 7(5): 1-19.

Abstract: From ancient time, malty propose institutes and organizations had involved to small tanks renovation in Sri Lanka. Nawdays Department of Agrarian Development, Irrigation Department, Samurdi Authority, Gamanaguma project and NGO's were involved for small tank renovation. They applied Remove soil from tank, Renovate tank bund, Remove plant cover on the tank, Slues repairing, Wana (spill) Repairing and Channel repairing as types of tank renovation. This renovation steps directly effect on amphibians and reptile species living in the tank environments. This research has been identified amphibians and reptile species changes living in the tank environment after small tanks Renovation. The study was conducted on 12 small tanks in Galgamuwa DS division in Kurunegala district where 77 no's of renovated tanks during last 15 years are located. Small tanks in Sri Lanka are those having an irrigated command area of 80 ha (1 ha = 2.47 acres) or less. Questionnaire survey for 150 households, 12 PRA activities and field plot transects were used for data collection. Crocodile distribution after the renovation has not changed. Before and after renovation

crocodiles are only rarely seen. Tank renovation has negatively affected on the distribution and population of Viper and Monitor. However other species including Iguana species, Water snake, Skink species, Chameleon species and Python can be seen in the tank surroundings abundantly before and after the tank renovation. According to the above facts small tank renovation has not influenced the populations of many reptile and amphibian species except Monitor and Viper. Reptiles and amphibian populations have declined only in the Bulnawa tank.

Vasilyan, D. (2019). Fish, amphibian and reptilian assemblage from the middle Miocene locality Gračanica-Bugojno palaeolake, Bosnia and Herzegovina. Palaeobio. Palaeoenv. (https://doi.org/10.1007/s12549-019-00381-8).

Abstract: This paper presents the first fossil fish, amphibian and reptilian fauna from Bosnia and Herzegovina Dinarides. The fauna of ectothermic vertebrates of the Bugojno palaeolake, dated to 15.2-14.0 Ma, composes of killifishes (Cyprinodontiformes indet.), a barb (Barbini indet. (aff. *Barbus*), a crocodile newt (*Chelotriton* sp.), a painted frog (*Latonia* sp.) and a crocodile (Alligatoroidea indet. [?*Diplocynodon*]). The crocodile remains are confined to the lower part of the section corresponding to the swamp deposit (unit 1). The remaining fauna, which includes fishes and amphibians, come from the upper lacustrine unit 2. A possible *Barbus* (Barbini indet. (aff. *Barbus*)) could represent one of the oldest fossil records of the genus found in Europe, which composes of skeletal elements and pharyngeal teeth. The crocodile newt (*Chelotriton* sp.) represents the first record of this group from the area. For the first time, fossil tadpoles of the genus *Latonia* are described in this paper, which, moreover, are the first record of tadpole for both the family Discoglossidae and clade of discoglossoid frogs. The crocodile remains, identified as Alligatoroidea indet., should belong to the genus *Diplocynodon*, which will be tested later on a better preserved material. The fossils, coming from the lacustrine interval, are referred to the deeper water facies. Taphonomic observations of the fossil remains suggest relatively short phase of decay of the animal bodies and their (probably quick) sedimentation in the deeper parts of the lake, with poor oxygen content.

Sellers, K.C., Schmiegelow, A.B. and Holliday, C.M. (2019). The significance of enamel thickness in the teeth of *Alligator mississippiensis* and its diversity among crocodyliforms. Journal of Zoology (https://doi.org/10.1111/jzo.127070.

Abstract: Enamel is the hardest tissue in the vertebrate body. Although variation in enamel microstructure is often linked with diet, the gross proportions of the tissues that compose vertebrate teeth remain relatively unexplored in reptiles. To investigate the patterns of enamel thickness in crocodyliforms, we used micro-computed tomography scanning to evaluate enamel thickness in teeth of *Alligator mississippiensis* from rostral, intermediate and caudal locations in the tooth row from an ontogenetic range of animals. We also evaluated enamel thickness in the derived teeth of several extinct crocodyliforms with disparate craniodental morphologies. Our data show that enamel thickness scales isometrically with skull length. We also show that enamel is relatively thicker in caudal teeth than teeth in more rostral positions, concordant with the higher bite forces they experience during feeding. We compared our data with existing enamel thickness data reported from dinosaurs and mammalian taxa to find that archosaurs have markedly thinner enamel than most mammals. These findings serve as a basis for future investigations into the diversity and function of the proportions of dental tissues.

Poapolathep, S., Giorgi, M., Chaiyabutr, N., Chokejaroenrat, C., Klangkaew, N., Phaochoosak, N., Wongwaipairote, T. and Poapolathep, A. (2019). Pharmacokinetics of enrofloxacin and its metabolite ciprofloxacin in freshwater crocodiles (*Crocodylus siamensis*) after intravenous and intramuscular administration. J. Vet. Pharmacol. Ther. (doi: 10.1111/jvp.12791).

Abstract: To the best of the authors' knowledge, pharmacokinetic information to establish suitable therapeutic plans for freshwater crocodiles is limited. Therefore, the purpose of this study was to clarify the pharmacokinetic characteristics of enrofloxacin (ENR) in freshwater crocodiles, *Crocodylus siamensis*, following single intravenous and intramuscular administration at a dosage of 5 mg/kg body weight (b.w.). Blood samples were collected at assigned times up to 168 hr. The plasma concentrations of ENR and its metabolite ciprofloxacin (CIP) were measured by liquid chromatography tandem-mass spectrometry. The concentrations of ENR and CIP in the plasma were quantified up to 144 hr after both the administrations. The half-life was long (43-44 hr) and similar after both administrations. The absolute i.m. bioavailability was 82.65% and the binding percentage of ENR to plasma protein ranged from 9% to 18% with an average of 10.6%. Percentage of CIP (plasma concentrations) was 15.9% and 19.9% after i.v. and i.m. administration, respectively. Based on the pharmacokinetic data, susceptibility break point and PK-PD indexes, i.m. single administration of ENR at a dosage of 5 mg/kg b.w. might be appropriate for treatment of susceptible bacteria (MIC>1 μg/mL) in freshwater crocodiles, *C. siamensis*.

Codd, J.R., Rose, K.A.R., Tickle, P.G., Sellers, W.I., Brocklehurst, R.J., Elsey, R.M. and Crossley, D.A. II (2019). A novel accessory respiratory muscle in the American alligator (*Alligator mississippiensis*). Biol Lett. 15(7): 20190354 (doi: 10.1098/rsbl.2019.0354).

Abstract: The muscles that effect lung ventilation are key to understanding the evolutionary constraints on animal form and function. Here, through electromyography, we demonstrate a newly discovered respiratory function for the iliocostalis muscle in the American alligator (*Alligator mississippiensis*). The iliocostalis is active during expiration when breathing on land at 28°C and this activity is mediated through the uncinate processes on the vertebral ribs. There was also an increase in muscle activity during the forced expirations of alarm distress vocalizations. Interestingly, we did not find any respiratory activity in the iliocostalis when the alligators were breathing with their body submerged in water at 18°C, which resulted in a reduced breathing frequency. The iliocostalis is an accessory breathing muscle that alligators are able to recruit in to assist expiration under certain conditions.

Melstrom, K.M. and Irmis, R.B. (2019). Repeated evolution of herbivorous crocodyliforms during the Age of Dinosaurs. Current Biology (https://doi.org/10.1016/j.cub.2019.05.076).

Abstract: Extinct crocodyliforms from the age of dinosaurs (Mesozoic Era) display an impressive range of skeletal morphologies, suggesting a diversity of ecological roles not found in living representatives. In particular, unusual dental morphologies develop repeatedly through the evolutionary history of this group. Recent descriptions of fossil crocodyliforms and their unusual teeth provide the inferential basis for a wide range of feeding ecologies. However, tests of these hypotheses are hindered by the lack of directly comparable dental morphologies in living reptiles and mammals, thereby preventing an accurate ecosystem reconstruction. Here, we demonstrate, using a combination of the orientation patch count rotated method and discrete morphological features, that Mesozoic crocodyliforms exploited a much greater range of feeding ecologies than their extant relatives, including likely omnivores and herbivores. These results also indicate that crocodyliforms independently developed high-complexity dentitions a minimum of three times. Some taxa possess teeth that surpass the complexities of living herbivorous lizards and rival those of omnivorous and herbivorous mammals. This study indicates that herbivorous crocodyliforms were more common than previously thought and were present throughout the Mesozoic and on most continents. The occurrence of multiple origins of complex

dentitions throughout Crocodyliformes indicates that herbivory was a beneficial dietary strategy and not a unique occurrence. Many of these crocodyliforms lived alongside omnivorous or herbivorous synapsids, illustrating an ecological partition that is not observed today.

Lodge T.E. (2019). Overview of the Everglades. *In* Mercury and the Everglades. A Synthesis and Model for Complex Ecosystem Restoration, ed. by D. Pollman C., D. Rumbold and D. Axelrad. Springer: Cham.

Abstract: The Everglades is a freshwater wetland located in southern Florida. It originated 5500 years ago when rising waters of Lake Okeechobee and its vicinity fostered deposition of wetland soils through former uplands with widely exposed bedrock. Its development occurred in the presence of, and under the influence of Native Americans, their occupation having predated the Everglades by thousands of years. Prior to regional drainage, which began in the 1880s, the Everglades covered about 4000 square miles. It sloped southward at about 2.5 inches per mile from Lake Okeechobee to coastal tidal waters at the south end of Florida's mainland. Just over half of the Everglades remains today, mostly broken into water-conservation impoundments controlled by levees and canals with only Everglades National Park at the south end still free-flowing. Pristine areas of the Everglades are oligotrophic, consisting mostly of marshes rich in periphyton. The marshes and periphyton are rapidly degraded by phosphorus enrichment over the maximum background of 10 ppb. Other enrichment of concern is sulfur and its association with elevated methylmercury, the latter biomagnified in Everglades fauna. Everglades marsh landscapes include long-hydroperiod sloughs (flooded 11+ months annually) and intermediate-hydroperiod sawgrass ridges (flooded 9-10 months), both underlain by peat soils, and smaller areas of short-hydroperiod, mixed-herb marshes (mostly flooded 3-7 months) underlain by marl. The latter occur around the edges of the southern Everglades. Unevenly distributed through these marshes are tree islands of several kinds based on their genesis and flora. One type was frequented through history by Native Americans, which influenced island development. Recent work has demonstrated the role of water flow in the evolution and maintenance of marsh and tree-island landscape features, all aligned with the pre-drainage direction of flow. Other Everglades features include small ponds called alligator holes that have various origins but are maintained by alligators and are ecologically important. Surrounding the Everglades are other plant communities, principally forests, and most outflows of water from the Everglades pass through extensive and highly productive tidal mangrove swamp forests before entering shallow marine waters at the south end of the system. Everglades wildlife responds to summer wet-season and winter-spring dry-season cycling, which characterizes southern Florida's nearly tropical climate. Many introduced plants and animals have stressed the natural Everglades ecosystem, which supports 68 threatened and endangered species. Restoration efforts are in progress. Phosphorus reduction, initiated in the mid-1990s, has been successful but short of compliance targets. Overall ecosystem restoration is ongoing but slow. In combination with phosphorus reduction, it involves revision of South Florida's water-control system to ensure the right quality, timing, and distribution of water.

De Celis, A., Narváez, I. and Ortega, F. (2019). Spatiotemporal palaeodiversity patterns of modern crocodiles (Crocodyliformes: Eusuchia). Zoological Journal of the Linnean Society (https://doi.org/10.1093/zoolinnean/zlz038).

Abstract: Eusuchia is a crocodyliform clade with a rich and diverse fossil record dating back to the Mesozoic. There are several recent studies that analyse crocodyliform palaeodiversity over time, but none of them focuses exclusively on eusuchians. Thus, we estimated subsampled eusuchian palaeodiversity species dynamics over time not only at a global scale, but also by continents and main crocodylian lineages (Alligatoroidea, Crocodyloidea and Gavialoidea). These estimates reveal complex spatiotemporal palaeodiversity patterns, in which two maxima can be detected: the first during the Palaeocene and the second, which is also the biggest, in the middle-late Miocene. The Palaeocene shift is related to a North American alligatoroid diversification, whereas the middle-late Miocene maximum is related to a diversification of the three main Crocodylia lineages in Gondwanan land masses, but especially in South America. Additionally, a model-based study using generalized least squares was carried out to analyse the relationships between different abiotic and sampling proxies and eusuchian palaeodiversity. The results show that palaeotemperature is the most important factor amongst the analysed proxies, in accordance with previous studies. However, the results suggest that, along with palaeotemperature, other abiotic and/or biotic factors might also be driving eusuchian palaeodiversity dynamics.

Escobedo-Galvan, A.H., Elsey, R.M., Cann, F.M.C., Cupul-Magana, F.G.and Lopez-Luna, M.A. (2019). Putting eggs in one big basket: communal egg-laying between long-lived reptiles. North-Western Journal of Zoology 15(1): 96-100.

Abstract: Understanding communal nesting has provided a deeper insight into reptile social behavior. Conspecific communal nesting has been reported frequently, while interspecific communal nesting has remained somewhat opaque. Here, we report communal egg-laying involving long-lived reptiles (American Crocodile and Ornate Slider Turtle). Our results from both field observations and literature reviewed indicate this is the first known case of communal nesting between these two species, and could suggest that crocodilians provide secondary nest attendance for nesting turtles. In addition, we present a brief review of commensal egg-laying between crocodilians and other reptiles.

Steering Committee of the Crocodile Specialist Group

Chair: Professor Grahame Webb, P.O. Box 530, Karama, NT 0813, Australia
For further information on the CSG and its programs on crocodile conservation, biology, management, farming, ranching, or trade, contact the Executive Office (csg@wmi.com.au) or Regional Chairs

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

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

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

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

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

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

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

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

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

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

.

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

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

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

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

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

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

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

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

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

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

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