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COVER PHOTOGRAPH: Hatchling American Alligator (*Alligator mississippiensis*). Photograph: Dr. Ruth Elsey.

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The CSG Newsletter provides information on the conservation, status, news and current events concerning crocodilians, and on the activities of the CSG. The Newsletter is distributed to CSG members and to other interested individuals and organizations. All Newsletter recipients are asked to contribute news and other materials.

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Editorial

It is with sadness that we heard that long-time CSG member José Ayarzagüena Sanz (59 y) passed away in Madrid, Spain, on 28 December. José spent a good deal of his life in Venezuela, and will be sorely missed by his family, friends and colleagues from around the world (see page 4).

Following on from the Human-Crocodile Conflict Workshop held in Sabah, Malaysia, in June 2010, an International Crocodile Conference was held in Kuching, Sarawak, Malaysia, from 19-21 October 2011. The focus of the conference was "Human-Crocodile Coexistence". Information provided by regional Range States indicated that *C. porosus* populations in Sabah and Sarawak had increased considerably, and negative human-crocodile interactions were driving public sentiment against crocodiles. The major recommendation from the Conference was that Brunei, Indonesia and Malaysia consider a joint proposal to downlist *C. porosus* to Appendix II, with an annotation for Brunei (status unknown) and Peninsular Malaysia (population still depleted) maintaining zero quotas for export of wild specimens. A summary of the conference is on pages 5-6.

In November we received reports about the devastating floods in Thailand, and the effects of this natural disaster on the crocodile industry and planend conservation programs for that country. Substantial industry funds earmarked for *C. siamensis* reintroduction had to be diverted to victims of the floods and the recapture of escaped crocodiles (see page 15).

The CSG-Tomistoma Task Force has approved a grant of $US7350 to Boyd Simpson, to undertake a Status Assessment of Tomistoma in Selangor and Pahang States, Peninsular Malaysia. The project will be based at Universiti Kebangsaan Malaysia (UKM) and be undertaken in collaboration with staff at the Science University of Malaysia (USM).

The discovery of what is probably the most important *Crocodylus acutus* population in the Colombia is most encouraging. Recent surveys undertaken in the Sardinata River, Catatumbo region, have revealed a significant, well-established population (see pages 6-7).

As many members are aware, Akira Matsuda played a critical role in developing the CSG and CSG-Tomistoma Task Force websites, which we graciously acknowledge. But his circumstances have changed, and so we have been redeveloping the CSG website so that it can continue to be a core communication site for the CSG. We apologise for any inconvenience caused by the redevelopment process, but it will soon be over!

The 4th International Workshop on Crocodilian Genetics and Genomics will be held in Darwin, Australia, from16-18 May 2012. Enquiries should be directed to Dr. Sally Isberg (sally@crocfarmsnt.com). The timing of this workshop was established so as to allow participants to attend the 21st CSG Working Meeting in Manila, Philippines, that will convene a few days later on 22-25 May 2012.

Organisers of the 21st CSG Working Meeting would like to encourage participants to register and to submit presentations for consideration as soon as possible. Visit the meeting website (www.csgmanila.com), for information on the proposed program and events, registration, accommodation options, visa requirements and instructions to authors.

The second IUCN Species Survival Commission Specialist Group Chairs' Meeting will take place on 23-27 February 2012, in Abu Dhabi, United Arab Emirates. The CSG Chairman and Executive Officer have been invited to participate in the meeting. The purpose of the meeting is to provide an open platform for all Specialist Group (SG) Chairs and Programme Officers to share their experiences and discuss key work items of the SSC. The meeting also allows the senior leadership of IUCN and the SSC to express gratitude and recognition to the Chairs and members, who voluntarily dedicate their time and expertise to the SSC and to advancing species conservation efforts globally.

Professor Grahame Webb, CSG Chairman

Obituary

José Ayarzagüena Sanz

(27 November 1952 - 28 December 2011)

On 28 December 2011, José Ayarzagüena (59) passed away in Madrid, Spain, due to lung cancer which was detected too late for treatment. On learning of his condition, he took the news with much sobriety and strength, fully aware of the consequences. Jose is survived by son José Luis and family.

Born in Madrid, José completed his PhD at the Department of Biological Sciences at the Universidad Complutense de Madrid. In 1977 he arrived in Venezuela to study the ecology of *Caiman crocodilus* (Baba) in El Frio Ranch, Apure State. Results of this study were published in 1983, including an extensive bibliography on nutrition, biology, ecology, habits, reproduction, behavior and habitat use. This work was recently (2008) republished by the Asociación Amigos de Doñana, together with additional information that was not included in the original publication. This work provided the basis for the implementation of the Commercial Harvest Program of Baba (*Caiman crocodilus*) in Venezuela, and is also the basis of programs in Bolivia and Paraguay. With Javier Castroviejo and the Maldonado family, José founded the El Frio Biological Station, of which he was Director for more than 30 years. In that period, 10 doctoral studies, 30 bachelor special studies and some 120 publications were generated from this institution.

Also at the Biological Station, under José's direction, the captive breeding and ranching program of Orinoco crocodile (*Crocodylus intermedius*) was initiated, generating very important information for the species. Due to this interest in the Orinoco crocodile, **José** coordinated a group that obtained from the Ministry of Environment the declaration of the Caño Guaritico Wildlife Refuge in Apure State. The goal was to use the refuge as a protected area for the reintroduction of captive-bred Orinoco crocodiles. This action constitutes a major world-wide success for crocodile conservation. In 2006 the first Orinoco crocodile population established from the reintroduction program was identified in Caño Guaritico Wildlife Refuge.

Between 1991 and 1992 José was the Scientific Coordinator for a projects entitled "Evaluation of the populations of *Caiman crocodilus fuscus* in Black Waters and White Waters Wildlife Refuge in Zulia State, Venezuela" and "Population status of the Spectacled Caiman (*Caiman crocodilus*) in the Venezuelan Plain". In terms of surface coverage, the latter project was of the highest magnitude in Venezuela, and possibly any other country. It generated the basis for the allocation of sustainable harvests of *Caiman* populations in Venezuela by ecological regions - a modern concept at the time.

In 1994 José was a part of an international mission to Colombia, organized by CITES and the CSG, to evaluate the Babilla Captive Breeding Program there. He delivered a diverse range of training courses on surveying, captive raising, etc.

Another of José's passions was the study of frogs in Venezuela. He crossed the country, and together with colleagues, discovered and described many new genera and species. This contribution was recognised through the use of his name for two amphibians and one reptile (*Osteocephalus ayarzaguenai*, *Colostethus ayarzaguenai* and Typhophis *ayarzaguenai*).

In the field of academia, José was the Scientific Coordinator and professor of the Masters in Management of the Tropical Biodiversity of the University San Pablo CEU-Carolina Foundation. He supervised a diversity of graduate and postgraduate in Spain. In addition, he was: one of the scientific staff at the Museum of Natural History of the Salle Foundation of Natural Science; Associated Research of the Salle Foundation of Natural Science; Coordinator of the NGO Man and Nature in Bolivia; member of the Spanish Committee of the Program Man and Biosfera (MAB) of UNESCO; and, member of the Venezuelan Crocodile Specialist Group. To the CSG he was a valued long-time member.

His passing has been a shock to the scientific world, colleagues, students and friends, and everyone to whom he selflessly offered his generosity, lessons and realistic view on life. We will not forget his presence, commentaries, abilities in the field, and his intuition in solving scientific problems.

Dear José, we will always remember you, and I will especially be thinking of you when next eating paella and drinking red wine.

Alvaro Velasco *(compiled with information supplied by Rafael "Picu" Antelo).*

Summary Report on International Crocodile Conference

The International Crocodile Conference (ICC) was held at the Harbour View Hotel, Kuching, Sarawak, Malaysia, from 19-21 October 2011. Some 120 participants from 8 countries attended the meeting (Australia, Brunei, Bangladesh, France, Indonesia, Japan, Malaysia, Philippines, USA). The conference was a "follow on" from the CSG international Workshop on Human Crocodile Conflict (HCC) held in Kota Kinabalu, Sabah, June 2010, which addressed the issue of HCC within the North Borneo region, and the role "Crocodile Conservation through Sustainable Use" may play in management programs aimed at generating positive values for crocodiles despite the negative values associated with HCC.

The objectives of the ICC in Kuching were:

1. "To provide a forum for sharing information on research findings, crocodile conservation and human-crocodile conflict in the region.
2. To formulate strategic recommendations on crocodile distribution, habitats and risks due to HCC for East Asia-Australasian region with special focus on Borneo.
3. To provide a venue for capacity building for all participants on crocodile conservation, research and human-crocodile conflict management.
4. To enhance and establish collaboration on crocodile conservation and research programme with renowned national, regional and international leaders and institutions".

Participants were welcomed by Wilfred S. Landong, General Manager, PABC, Sarawak Forestry, and the Organising Chairman for the conference. The opening ceremony was conducted on the second day with the arrival of YB Tan Sri Datuk Amar Hj Adenan Hj Satem, Minister of Special Functions in the Chief Minister's Office. YBhg Datu Dr. Yusoff Hanifah, Chairman of Sarawak Forestry, delivered the welcome speech, which was followed by the keynote address by CSG Chairman Professor Grahame Webb, .

The theme for the conference was "Human-Crocodile Coexistence: Win-Win Formula", and presentations were allocated on the basis of four major themes:

1. Science (monitoring, techniques, data analysis), including an update on the Resolutions from the HCC meeting held in Kota Kinabalu, Sabah (June 2010);
2. Conservation and awareness (training, development, Human-Crocodile Conflict, protocols);
3. Business (trade, farming, CITES, tourism); and,
4. Status (reporting on status of crocodiles), including regional reports from Sarawak, Sabah, Peninsular Malaysia, Brunei and East Kalimantan (Indonesia).

Information provided by the Range States indicated that *C. porosus* populations in Sabah and Sarawak had increased considerably, and negative human-crocodile interactions were driving public sentiment against crocodiles. The current status of *C. porosus* in Brunei is unclear, due to a lack of population data in most areas where the species occurs, but there have been some recent fatal attacks on humans. Likewise, there are no recent data for the species in Kalimantan, although anecdotal information suggests that there has been some recovery there. The *C. porosus* population in Peninsular Malaysia remains depleted.

Late on the second day, following a presentation by Tom Dacey (CSG Executive Officer) on "Down-listing of crocodilian populations from CITES Appendix I to Appendix II", participants broke into three workshop groups to address the following topics: Sciences and Status; Conservation and Awareness; and, Business. The outcomes of the workshops were delivered in Plenary on the final day and provided the basis of the following recommendations from the Conference Chairman.

<u>Recommendations</u>

Science and Status

1. Develop standardized survey (monitoring) programs and comprehensive databases.
2. Re-assess all existing survey data and develop/modify survey programs that allow population status and trends to be quantified.
3. Identify, categorize and quantify all natural crocodile habitats.
4. Develop strategy and management regimes for a CITES down-listing proposal.
5. Ensure core funding availability from government for long-term monitoring and management whilst encouraging involvement by the private sector.
6. Enhance collaboration and information sharing between Brunei, Malaysia and Indonesia (Kalimantan) in the management of crocodile populations.
7. Improve scientific skills and the use of traditional knowledge of crocodiles through capacity building.
8. Range states (Brunei and Malaysia) are encouraged to submit a proposal to downlist *C. porosus* to Appendix II (with annotation for Brunei and Peninsular Malaysia to maintain a zero export quota for wild specimens).

Conservation and Awareness

9. Develop and implement education programs for primary, secondary, tertiary students on crocodile management.
10. Develop standards and guidelines on safety practices in crocodile habitats.
11. Cooperate with media on communicating crocodile conservation and management program.
12. Develop human capital in crocodile management through education, training and capacity building.

Business

13. Establish a working group comprising of stakeholders to draft comprehensive business model.
14. Ensure incentive driven crocodile businesses that benefit affected local communities.
15. Formulate a legal and institutional framework to promote

crocodile businesses through government driven programs.

The major recommendation from the Conference was that Brunei, Indonesia and Malaysia consider a joint proposal to downlist *C. porosus* to Appendix II, with an annotation for Brunei (status unknown) and Peninsular Malaysia (population still depleted) maintaining zero quotas for export of wild specimens. That is, a proposal would need to take into account the variable status of the species among the different sub-regions. The Kalimantan population of *C. porosus* is currently listed on CITES Appendix II, but with conditions that do not allow international trade in wild specimens (use and trade in wild *C. porosus* in Indonesia is currently restricted to Papua Province, with production through captive breeding elsewhere).

It was noted that a downlisting proposal would need to be prepared and submitted to the CITES Secretariat by the end of September 2012, in order to comply with Resolution Conf. 9.24 (Criteria for amendment of Appendices I and II) and for consideration by the 16th Conference of the Parties to CITES (Bangkok, Thailand, 3-15 March 2013).

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

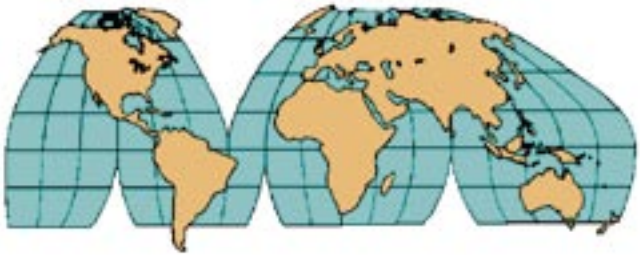
CSG Student Research Assistance Scheme Update

The CSG Student Research Assistance Scheme has provided funding to a further students, bring the total to 8 in 2011 so far:

1. María Virginia Parachú Marcó, McNeese University, USA: "Determine the effect of *Solenopsis invicta* venom on physiological and morphological parameters in *Alligator mississippiensis*".

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

Regional Reports



Latin America and the Caribbean

Colombia

NATURAL POPULATIONS OF CROCODILES DISCOVERED IN THE CATATUMBO REGION. Colombian scientists have determined that the Sardinata River basin in Norte de Santander State is the habitat of the most important population of "Caiman aguja" (*Crocodylus acutus* Cuvier, 1807) in Colombia.

Within the plan of management for wildlife being developed by the Ministry of Environment and Sustainable Development and the Regional Autonomous Corporations at Colombia, the conservation of crocodilians figures prominently in some of the strategies for biodiversity conservation. The Corporation Autonomous Regional of the North Border Eastern (CORPONOR), as the environmental authority of Norte de Santander, tends towards the conservation of biodiversity and environmentally sustainable development. In this regard in 2010 and 2011, together with the Colombian Petroleum Enterprise (ECOPETROL), developed a research program looking at the medium- and long-term conservation of *C. acutus*) in the Catatumbo region with the participation of local communities.

Colombia ranks first in diversity of Crocodylidae, having 6 of the 23 crocodilian species. *Crocodyus acutus* is listed in Colombia as in danger of extinction, is included in the IUCN Red list as "Critically Endangered", and is on Appendix I of CITES. Populations have decreased dramatically in the country due to pressure for the skin trade, mainly in the last century. However, within the national context, the status of this species in the Catatumbo region could be one of the best, as indicated by the results of the recent investigation. This situation is relevant from the ecological perspective and opens up a range of possibilities for research, education and socio-economic development, as with similar crocodylid populations in other latitudes.

In June 2009, an unfortunate accident in the locality of Villa del Carmen, Sardinata River, brought to public light the presence of crocodiles in the region and through national and regional dissemination generated the need to find out about the species.The accident involved the drowning of a 6-year-old girl died, caused by a 3.8 m long crocodile weighing 175 kg, and in part by the carelessness and neglect by the girl's guardians - the river is the natural habitat of the species and was public knowledge that large crocodiles existed at that site. The crocodile was hunted by the fishing community of the area.

Given these facts, CORPONOR asked the Ministry of the

Environment for support to confront the situation; the Ministry asked Colombian expert and biologist, Giovanni A. Ulloa D. to propose and coordinate the research activities. Giovanni Ulloa, together with Juan M. Peláez Montes from the National University, and with the support of CORPONOR-Tibú and ECOPETROL-Tibú, drew up a "Preliminary Management Plan for the Conservation of Populations of Caiman Aguja *Crocodylus acutus* (Cuvier, 1807) in Sardinata, San Miguel, New President and Tibu Rivers".

In addition to the research results themselves, the study allowed the establishment of possible strategies to ensure the conservation of biodiversity, including crocodiles in the Sardinata River basin. Today we know the location of and status of the crocodile populations for much of the Sardinata River basin, and also what should be done for immediate conservation: research, education, community participation and declaration of protected areas. These are some of the main strategies proposed in the preliminary plan.

The main result of the research was the discovery and documenting of the most important population of *C. acutus* in the country, on the basis of abundance and population structure. The 132 km survey of the Sardinata, San Miguel, New President and Tibú Rivers indicated 196 crocodiles (total density of 1.48/km), and an estimate of several thousands of animals. Also the research concluded that deforestation in gallery forest formations was the most significant alteration of the ecological context in the four rivers, with direct influence on crocodile habitats.

CORPONOR, as environmental authority and governmental organization, has the tools to guide conservation actions of the species in Sardinata River basin, has the support of the Ministry of Environment and Sustainable Development, and has ECOPETROL as a strategic partner. It also is the generator of social and economic welfare for the region, and is committed to the health of the environment and biodiversity conservation. All the participants and those who helped with the results of this study should feel pride in the contribution made to the conservation of a species in danger of extinction.

Giovanni Andrés Ulloa-Delgado, *Especialista en Manglares y Fauna Silvestre, croco_mangle@hotmail.com.*

Mexico

AMERICAN CROCODILE RECOVERY AT SUMIDERO CANYON NATIONAL PARK, CHIAPAS, MEXICO. In 1993, Miguel Alvarez del Toro Zoo's (ZOOMAT) staff started a conservation program for the American crocodile (*Crocodylus acutus*) at the Sumidero Canyon National Park (SCNP) in Chiapas State, Mexico. The area was affected significantly in 1980 when the "Mario Moreno Torres" hydroelectric dam (aka Chicoasen) was built. Basically the area was flooded and the original river margins were left 200 m under the new water level. The known nesting areas were submerged and the surviving crocodiles swam some kilometers up river, where the place offered new good habitat, outside the 700 m high walls of the canyon (Sigler and Ramirez 2000). The area was decreed as a National Park on 8 December 1980.

In 1992, only one crocodile nest was detected, but the number increased in upcoming years (Fig. 1). The activities carried out by ZOOMAT were: night and day crocodile counts, capture-mark-recapture, nest counts, artificial incubation at the zoo, and release of the crocodiles hatched at the zoo after one or two years of age. On 2-3 June 2011, we went back to the SCNP to carry out night counts, review nesting activity and success, and to photograph some marked crocodiles. The night counts did not really indicate a recovery of the crocodile population (only 22 crocodiles spotted in 15 km of river, encounter rate= 1.46/km), which could be because these crocodiles are mostly shy during night counts; but during day incursions to the area, many crocodiles were seen.

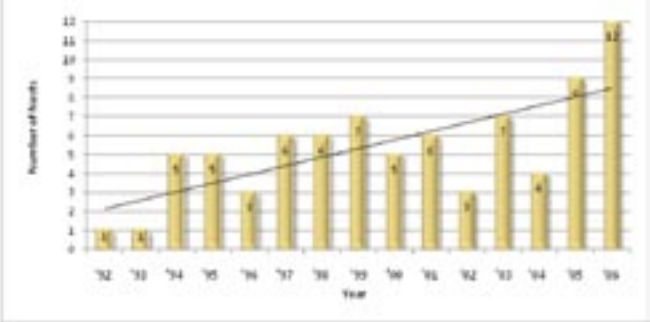


Figure 1. American crocodile nests detected at Sumidero Canyon National Park, 1992-2006. Adapted from Luis Sigler (1992-2004) and Dominguez (2005-2006).

Hatching in SCNP starts in mid-May, but usually spans the last week of May and the first days of June (Sigler 2010). During this evaluation, we found 11 nests, all of which were successful, and only a couple of infertile eggs were detected in the remaining nest holes. The number of nests detected this year is similar to the highest number (12) found in 2006 (Fig. 1), where some new females - probably released ones from the project - were incorporated into the breeding group. All nests showed hatching assistance by the/a mother crocodile, and all of them had eggshells with signs of emerged hatchlings. Based on the size of the eggshell (75 mm in length), we estimated the females were not primipara. Six of the nests were located in a colonial arrangement in the area known as "El Tomatal" (Fig. 2); two more nests were in a nearby area, and the other three were in different locations.

Four females were spotted at night, close to hatchlings groups (up to 30 individuals each). The hatchlings were by the rocky shore in the water or outside the river, but only half a metre apart. One unmarked female submerged when we came close to a hatchling group at night, but we were able to take some photographs while she was under the clear water of the Grijalva River (Fig. 3).

Figure 2. Colonial nesting (5 nests) at El Tomatal. Photograph: Luis Sigler.

Figure 3. Submerged female *C. acutus* guarding hatchlings during night survey of Grijalva River. Photograph: Carlos Navarro S.

Three crocodiles were photographed during daytime and their markings checked. The marking system used incorporates the "year of hatch" and a progressive number in that year. The database generated in the 1990s and early 2000s was reviewed, and important information obtained. Two large crocodiles were able to be photographed during the daytime as we approached them in a large boat like the ones used for tourist trips.

Mean growth rates were calculated for three marked crocodiles: No. 425 (Fig. 4), hatched 1994 (17 years), estimated TL of 3.5 m; mean growth rate= 18.8 cm/y; No. 754 (Fig. 5), hatched 1997 (14 years), estimated TL of 3.0 m; mean growth rate= 19.3 cm/y; No. 2279 (Fig. 6), hatched 2002 (9 years), estimated length of 2.2 m; mean growth rate= 24.4 cm/y.

Figure 4. American crocodile No. 425 (17 years; 3.5 m TL). Photograph: Oscar Mendoza.

Figure 5. American crocodile No. 754 (14 years; 3.0 m TL). Photograph: Luis Sigler.

Figure 6. American crocodile No. 2279 (9 years; 2.2 m TL). Photograph: Luis Sigler.

These preliminary growth data suggest that our previous estimates of growth rates were underestimated. For example, 4-m long *C. acutus* were thought to be more than 30 years old, but these data suggest that these lengths could be reached at younger ages. These growth rates supports the contention that this species can be one of the largest, as the historical length record for the area is 6.25 m (Alvarez del Toro 1974).

The number of *C. acutus* nests in the SCNP has increased since 1993, and a photographic bank of more than 100 crocodiles shows that marked aninals are doing well. The current *C. acutus* population in the SCNP is estimated to be 180 non-hatchlings. Migration of crocodiles outside the National Park (upstream and downstream) has been recorded, and it will be important to continue with a management plan for this population to avoid negative human-crocodile interactions. The American crocodiles are an important touristic resource at the SCNP. The boat trip is worth enough, because of the majesty of this natural wonder, but if tourists can see crocodiles - which are definitely common - it has made their day.

Acknowledgements

I wish to thank photographers Carlos Navarro Serment and Oscar Mendoza Mayorga for their support in the field. The Sumidero Canyon National Park Department provided fuel for the outboard motor boats for the surveys. Special thanks to park ranger Daniel Santos Ramirez for his assistance during day and night surveys.

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Venezuela

TRANSLOCATION OF AMERICAN CROCODILES TO NORTHERN LAKE MARACAIBO BASIN, VENEZUELA: MINIMIZING CONFLICT BETWEEN PEOPLE AND CROCODILES. The American Crocodile (*Crocodylus acutus*) inhabits many areas of the Lake Maracaibo basin, although in isolated and depressed populations (Barros *et al*. 2005). Its geographic distribution in this large ecosystem comprises the entire lagoon, as well as all the rivers that flow into this vast system (eg Santa Ana, Santa Rosa, Negro, Limón, Palmar, Machango, Chama, Torondoy). Additionally, the American Crocodile is common in some dams, such as Pueblo Viejo and Machango in Zulia State, and in the vicinity of Isla de Toas, Zapara, stretch of San Carlos, Bahia del Tablazo and coastal system of the Refugio de Fauna Silvestre and Fishing Reserve "Ciénagas de los Olivitos" (RFSRP-CO) (Seijas 1986; Lander and Bérmudez 2008). In this last protected area, there is a resident population and a program for releasing individuals with the purpose of increasing the population (Lander *et al*. 1994; Velasco 1999).

The crocodiles released into this refuge come from national zoos and aquariums, conservation programs, and from private collections. Furthermore, some individuals from conflict situations, such as those removed from areas near urban, recreational, commercial and industrial areas, have been translocated. Since November 1996 a total of 214 individuals have been released into this reserve.

The relocation of several individuals in many cases has been preceded by public alarm, generated by frequent sighting of individuals in very crowded places (eg city market, La Marina-Mirador recreational park, reparation boat company and regional petro-chemical installations). The alarm has resulted from over-reaction and misunderstanding, produced by malicious news that has been displayed through internet, radio, TV and locals newspapers. Here we present a current re-count of those individuals that have been moved for this last cause showing some captures and relocations. In all cases the specimens were released on an area of the RFSRP-CO (10° 57´ 01.47" N, 71° 27´ 08.96" W; La Palua Lagoon, see point Lib. on Figure 1). Table 1 shows data for 12 translocations, including biometric information. The authors participated in the capture, immobilization and translocations, along with firefighters, fishermen, employees of the industries affected by the presence of these crocodilians, ecologists, Venezuelan Ministry of Environment personnel, as well those associated with universities and the local zoo.

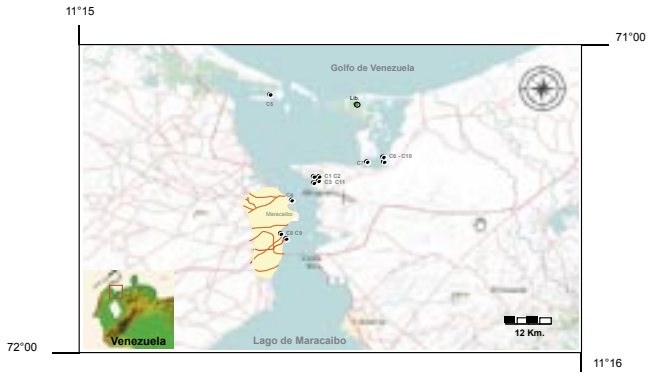

Figure 1. Locations at Lake Maracaibo basin where *C. acutus* were captured (C1-C11) and where they have been released ("Lib.") within the RFSRP-CO, Zulia State, Venezuela.

The relocated specimens have been encountered from coastal regions to small water bodies, artificial channels, creeks and inlets. Many of these places are surrounded by patches of vegetation, mainly mangroves and have been strongly modified with respect to the shoreline and water quality (generally polluted). Some factors that could explain the presence of these individuals in those places could be: a) historical site fidelity, represented by the ecological and genetic ancestral habitats of the geographic distribution of this species in this area in the Lake Maracaibo basin; b) individuals were raised in captivity and later released by their keepers because of the difficultly of captive maintenance or possible escape; c) dispersing individuals that have left home searching for a more suitable environment including access to food, space, breeding, or other factors.

We are sure that the strategy of translocation will continue in the future, however it requires the identification of new locations to introduce these individuals to ensure their long-term survival. It is important to consider marking all individuals and possibly establishing a tracking system (eg satellite tracking) in order to learn more about the biology and movements that these animals engage in after to being released.

Table 1. Details of *C. acutus* relocated to Lake Maracaibo. IPT= Instalaciones de la Petroquímica el Tablazo, Municipio Miranda, Zulia; SAA= Salinas artesanales Del Ancón, Município Miranda; AO = Astillero Omica, cerca de la Terminal de Buses, Municipio Maracaibo; EP= Empresa Produsal, Ancón de Iturre. Municipio Miranda, Zulia; IT= Isla de Toas, Município Almirante Padilla, Zulia; PRM= Parque Recreacional Marina norte, Milagro, Municipio Maracaíbo. Specimens C1, C2, C3 and C11 were found in diverse channels, generally artificial and inside the IPT.

No.	Date of Capture	Capture Location	Sex	TL (m)	BWt (kg)
C1	Feb 2002	IPT	F	2.58	-
C2	6 Feb 2003	IPT	F	2.80	95
C3	27 Oct 2003	IPT	F	2.82	92
C4	17 Sep 2005	PRM	M	2.87	88
C5	1 Jun 2006	IT	M	0.82	3
C6	16 Jun 2006	SAA	M	0.70	2.8
C7	6 Dec 2006	EP	?	0.45	0.4
C8	26 Aug 2007	AO	M	2.6	75
C9	8 Mar 2009	AO	M	2.27	52
C10	25 Aug 2009	SAA	M	1.44	10.2
C11	9 Oct 2009	IPT	F	3.15	170
C12	3 Nov 2010	IPT	M	3.20	160

Notes: C4 (Fig. 2) - locals called newspapers and named it as "Juancho:. Curiously, local people used the same name for later specimens (C8, C9). "Juancho" alludes to the old cartoon crocodile "Wally Gator", which was translated as "Lagarto Juancho" on Venezuelan TV during the 1970s and 1980s.

Figure 2. "Juancho" (C4; Table 1) was temporally transported to an enclosure in "Vereda del Lago" Park prior to its release.

Figure 3. American crocodile (C9; see Table 1) being released at the RFSRP-CO.

Acknowledgements

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Costa Rica

WORLD-FAMOUS CROCODILE "POCHO" DIES. Pocho, the Costa Rican American crocodile (*Crocodylus acutus*) that gained international media attention for a weekly show he performed with owner Gilberto Sheedan (54), died in October 2011, in the town of Siquirres. The crocodile is believed to have died from natural causes.

Every Sunday, Pocho and "Chito" as Sheedan was better known, performed a show for visitors in a 100 m^2 artificial lake at Finca Las Tilapias. Chito could command Pocho to do tricks such as winking its one good eye, lifting its head and tail out of the water, rolling over and permitting Chito to stick his head inside the massive reptile's mouth.

Chito had found the 5 m crocodile near death on the shore of the Parismina River, in Limón Province, 17 years earlier. Pocho had been shot in the left eye, and Chito and friends took him to Siquirres, where he was nursed back to health. Chito even slept with Pocho during his recovery.

After Costa Rica's Channel 7 filmed the unusual pair in July 2000, Chito and Pocho became stars, receiving attention as far as the USA, Chile and the United Kingdom. The Environment, Energy and Telecommunications Ministry allowed Chito to keep the crocodile as long as they could monitor it. Chito worked with a veterinarian and a biologist and fed Pocho 30 kg of fish and chicken per week.

Sources: http://www.ticotimes.net/Current-Edition/News-Briefs/World-famous-crocodile-Pocho-dies-in-Siquirres_Wednesday-October-12-2011#.TpbWiMQ8JCE.email; http://www.metro.co.uk/weird/878970-costa-rican-locals-mourn-as-celebrity-crocodile-pocho-dies-aged-60.

Europe

Belgium

TAX RAID TURNS UP CROCODILIANS. A tax raid on a residence in Damme, northwest Belgium, turned up more than investigators anticipated - 11 Nile crocodiles (*Crocodylus niloticus*) and one alligator hidden behind concealed doors. The villa's owner, a 51-year-old German man, did not have a licence to keep the animals, and has been charged with animal neglect.

The crocodilians had been kept in very bad conditions, but are expected to survive. They are now being looked after by an animal welfare centre which specialises in reptiles. The animals measure just over one metre in length, and had been kept at the villa since 2005.

Source: *BBC News Europe, 23 December 2011 (http://www.bbc.co.uk/news/world-europe-16315130).*

North America

USA

"SHIELDCROC" DESCRIBED. On the basis of a chunk of skull excavated in Morocco, and acquired by the Royal Ontario Museum of Canada from a collector, US scientists have described a new species of ancient crocodile with a strange, shield-like skull. Examination of the skull revealed that it belonged to a new and enormous species. The head was about 2 m long, with a shield-like structure on the top of the skull. It is considered likely that "shieldcroc," as the new fossil is known, would have used this structure for display.

Source: *Stephanie Pappas, LiveScience, 6 November 2011, "Ancient Monster Croc Sported Shield on Skull" (http://www.livescience.com/16896-giant-shield-croc-crocodile-fossils.html).*

South Asia and Iran

India

ASSESSING TILAPIA HEALTH FOR CLUES ON GHARIAL DIE-OFF IN THE CHAMBAL RIVER. *Gavialis gangeticus* (Gmelin, 1789) is endemic to the Indian subcontinent, with anthropogenic influences resulting in a 58% reduction in population size over the past decade (IUCN 2007; Whitaker *et al*. 2008). Over 85% of the global wild population of this critically endangered species is held in central India, within the Chambal River - a tributary of the Yamuna River and part of the greater Gangetic drainage system (Hussain 2009).

In an event that further compounded this precarious situation, during the winter of 2007-2008 more than 110 sub-adult and adult Gharials were found dead or dying in the Chambal River (Whitaker *et al*. 2008). The majority of deaths were near the Chambal's confluence with the Yamuna, where the riverine stretch of the Yamuna between Wazirabad barrage and the Chambal confluence is understood to be critically polluted (Sharma and Kansal 2011). Although no definitive diagnoses were made at the time of the die-off, autopsies indicate that ingestion of nephrotoxin(s) resulted in visceral and articular gout. Additionally, the observation of unexpected amounts of fat in animal tissues was presumably from abundant consumption of the invasive Mozambique tilapia (*Oreochromis mossambicus*) (Whitaker *et al*. 2008; P. Martelli, pers. comm.). Circumstantial evidence suggested that Gharials might have consumed non-native tilapia, with the latter acting as bio-accumulative carriers of toxins from highly polluted stretches of the Yamuna River to a relatively less polluted river such as the Chambal.

In order to test this hypothesis, an initial study carried out in 2008 (T. Rainwater and S. Singh 2008, unpublished study) was extended in 2010/2011 through financial support from the Ministry of Environment and Forests (MoEF), Government of India. In order to reflect relative systemic health, an examination of health indices of tilapia was conducted over three seasons (Post-monsoon, October 2010; Winter, February 2011; Pre-Monsoon, May, 2011) along a potential pollution gradient of 6 sampling localities across the Chambal (2) and Yamuna (4) Rivers. Gills, muscle and liver samples were also collected from 4 sites on the Chambal (1) and Yamuna (3) Rivers during winter and subsequently analyzed for heavy metals (eg lead) at the Indian Institute of Toxicological Research (IITR), Lucknow.

A total of 146 tilapia specimens were collected over the study period across all sampling localities. Fulton's Condition Factor (CF), which equates to growth in weight and volume, was found to bear significant relationships with sampling

locality (ANOVA, F= 9.041, p<0.001) and season (ANOVA, F= 23.427, p<0.001) and showed a higher order interaction of locality and season terms (ANOVA, F= 14.050, p<0.001). *Post-hoc* tests showed that CF values were higher at upstream sites on the Yamuna River while observed values at Chambal sites were lower than those of upstream sites on the Yamuna. Condition indices reflect 'general well-being' of an organism and it would be expected that CF would deteriorate across a potential pollution gradient from sites on the Chambal to localities on the Yamuna River. The discrepancy observed in site-specific variation of CF might be due to inadequate sample sizes from the Chambal River. In addition, CF is likely to vary with age, sexual activity and feeding patterns, in addition to general habitat conditions and ecological needs. Lowest values of CF were seen during winter. The reported seasonal variation in CF might be explained in terms of greater energy expenditure during winter leading to a decrease in lipid content of tissues resulting in relatively low levels of observed CF (Raymond *et al*. 2010).

Toxicological analyses showed that lead concentrations varied significantly with type of tissue (ANOVA, F= 60.839, p<0.001) and locality from which tissue sample was collected (ANOVA, F= 8.297, p<0.001), although no higher order interaction of terms was observed. Post-hoc tests revealed that lead concentrations were highest in gills. Observed lead concentrations in gills might result from complexing of metals with mucous, however high lead levels in gills might also result from feeding on benthic organisms and detritus (Yilmaz 2009). Lead content was significantly higher in tissue samples collected from sites on the Yamuna River; which would reflect bioaccumulation in tissues of fish that occur in relatively polluted sites. Muscle tissue also held higher metal levels than liver samples, with lead concentration in muscle samples of tilapia exceeding European Commission (2005) standards (0.2 mg/kg), and posing a potential risk for human consumption of tilapia. Lead is a neurotoxin that could accumulate in bones and soft tissue upon consumption and merits further monitoring.

In a caveat to significant relationships observed in the analysis of condition indices as well as heavy metal uptake - age and sex specific variation of sampled specimens has not been accounted for and might confound the results observed.

The broad trends detected through this study need confirmation through future studies focused on obtaining robust samples while accounting for potential sources of variation in condition indices and toxicological analysis. The suite of toxins that would be tested for also needs to be broadened to include persistent organic pollutants (dioxins, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans) from agricultural fertilizers. Laboratory studies of tilapia, so as to develop toxicity bio-markers, are also required.

The Gharial deaths of 2007/2008 underscore the need for stricter enforcement and monitoring of industrial effluent treatment protocol along with harsh punitive measures to counter violations. Local communities could also be educated on the relative benefits of organic farming and a pilot project to market these 'organic products' could also be initiated.

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Iran

IRAN RECEIVES CROCODILES FROM THAILAND. Twenty crocodiles, imported from Thailand, have been brought to Qeshm Island, Iran. The crocodiles varied between 1 and 7 years of age. According to farm owner Maisam Salarvand, around $100,000 has been spent to transfer the animals to Iran. The crocodiles will form the nucleus of a breeding group, with the eventual aim of producing skins and other products.

Source: Iranian Students' News Agency, 31 October 2011 (http://www.isna.ir/ISNA/NewsView.aspx?ID=News-1881588&Lang=E).

East and Southeast Asia

Philippines

"LOLONG" CONFIRMED AS WORLD'S LARGEST CROCODILE. The capture of an exceptionally large Saltwater crocodile (*Crocodylus porosus*) in Agusan del Sur Province of Mindanao, Philippines, made international headlines on 3 September 2011. The capture came after a 2-year effort to remove the animal thought responsible for a young girl's death at Agusan Marsh in early March 2009, and later the disappearance of a fisherman close to Bunawan village. Ernesto "Lolong" Cañete, an experienced member of the Palawan capture team involved in these efforts, died of a heart attack in late August 2011, shortly before the crocodile was eventually captured - the crocodile was named "Lolong" in his memory.

There was considerable interest in Lolong's length, with media outlets reporting his size between 6.1 and 6.4 m (20-21'). Photographic and video evidence clearly showed his size to be exceptional. I was fortunate to be invited by Natural History New Zealand and National Geographic to take part in a television documentary about Lolong. This provided an excellent opportunity to obtain accurate measurements and verify Lolong's size. Our visit took place between 9 and 10 November 2011, with the consent and cooperation of the Protected Areas and Wildlife Bureau (PAWB), Palawan Wildlife Rescue and Conservation Center (PWRCC) and local Bunawan officials, including Mayor Edwin Elorde.

Lolong's capture was coordinated by PWRCC members, including Palawan Wildlife Specialist Ronnie Somiller. The crocodile was snared using a baited steel noose secured to a tree, after he had triggered and successfully escaped from at least three smaller nooses, the remains of which were still fastened to his jaw when he was captured. After being secured with ropes, dozens of people were needed to haul Lolong along the riverbank to the village. A floating pontoon was necessary to carry him across the creek to the village. Eventually he was transferred by road to nearby holding facilities, and now resides at Bunawan Eco-Park and Research Center, where he attracts considerable tourist visitors daily. By early November Lolong had earned P500,000 ($US11,374) in tourism for the Center and the Barangay Consuelo (administrative area). This figure is almost certain to rise, with a P200 million ($US4.56 million) expansion planned for 2012. Mayor Elorde hopes that Lolong will help to drive protection of Agusan Marsh.

Lolong was measured in his enclosure at the Eco-Park on 9 November 2011 at 2 pm local time. His pool was drained, leaving him lying relatively straight on a flat-bottom concrete base. Measurement conditions were considered ideal. A combination of chemical and physical restraint was used to ensure the crocodile's welfare during handling, to ensure safety of personnel, and to facilitate accurate measurement. Chemical restraint involved using pancuronium bromide (2 x 2 mg 40 minutes apart) to provide temporary partial immobilisation (see Bates *et al*. 2004) and diazepam (10 mg) for mild sedation. Lolong was outside the size range of crocodiles for which either drug had previously been tested, and we were understandably conservative with dose rates. We used the minimum dose to get the job done safely without compromising welfare. Induction took nearly two hours, sufficient for safe handling and measurement. Drugs were allowed to metabolise naturally, and within 6 hours of injection Lolong was exhibiting normal behaviour. Breathing rate was monitored throughout the procedure without incident.

Physical restraint included ropes to control the head and to close the jaws remotely. After the eyes were covered, a small experienced team "jumped" the crocodile from behind to secure the jaws, lift the limbs from the ground to prevent traction, and provide restraining weight. Once secured, Lolong's head and tail were straightened prior to measurement (Fig. 1).

Figure 1. Lolong being measured. Photograph: Natural History New Zealand/National Geographic.

To address possible disagreement over the best measurement method, it was decided to use two methods for comparative purposes. The first ("Method A", Table 1) used a steel tape down the dorsal midline from snout tip to tail tip following the slope of the skull and latter part of the tail. The second ("Method B", Table 1) used the horizontal distance from snout tip to tail tip exactly parallel to the ground. In practice "Method B" gave fractionally shorter lengths than "Method A" (by around 1% in large individuals) and yet "Method A" is more frequently used because it is more practical especially with large individuals that are difficult to move. Measurements using "Method A" have been widely quoted in the press because it allows more meaningful comparison with measurements of other large crocodiles. It should be noted that Lolong's tail was 100% complete. Snout-pelvis length was used as a substitute for snout-vent length, as it was highly impractical to roll such a large crocodile onto its back, and there were also concerns about his welfare.

Table 1. Head dimensions and length measurements for Lolong [based on Webb and Messel 1978, except for: [1]distance from tip of the premaxilla to the caudal midpoint of the cranial platform, [2]linear distance from ground to highest point on cranial squamosal bone, [3]distance from tip of premaxilla to caudal edge of pelvic limb joint, as a correlate with snout-vent length (after Webb and Messel 1978), [4]distance from tip of snout to the junction between double and single tail scutes (verticils)]. Method A is considered the principal measurement (see text for differences between methods). All "length" measurements were taken from tip of the premaxilla (snout). All "width" measurements were taken at the widest point.

Measurement	Method A	Method B
Head length (mm)[1]	700	694
Snout-eye length (mm)	496	495
Maximum head width (mm)	450	450
Cranial width (mm)	228	228
Inter-orbital width (mm)	84	84
Cranial height (mm)[2]	363	363
Snout-pelvis length (mm)[3]	2851	2844
Snout-scute junction (mm)[4]	4982	4949
Total length (mm)	6170	6095
Total length (feet, inches)	20' 3"	20' 0"

The initial total length measurement taken by Mayor Elorde shortly after Lolong's capture was only slightly higher than the one obtained here. This slight over-estimation was likely due to the crocodile's posture lying on a cart with his tail hanging onto the ground. The weight of the tail muscle was sufficient to pull enough vertebrae apart to add around 20 cm of total length, highlighting the need for measurements to be taken on flat, level ground.

Lolong's mass (1075 kg, 2370 lb) was measured at a nearby truck weigh-bridge during transport to the holding facilities on 3 September 2011 (Edwin Elorde, pers. comm.). It was logistically impractical to verify this during our visit, but there is no reason to believe that rigour in this measurement was lacking, and it should be considered valid.

Lolong appeared to be healthy and in very good body condition. Some recent superficial scars were recorded on the snout, flanks and tail, caused by rope burn and snare abrasion during capture. These injuries were healing normally with no external signs of infection: scabs had fallen off, leaving fresh, light-coloured skin tissue underneath that was starting to regain pigmentation. Lolong began eating one month after capture (4 October 2011) and has eaten well since. Both the rapid healing of injuries and resumption of feeding behaviour are good signs that he is not suffering significant stress. Both his diet and his current facilities are certainly adequate, but recommendations are being made on improving both for his long-term well-being.

All measurements taken during our visit have been provided to Guinness for review, but there seems little doubt that Lolong, at 6.17 m total length, will replace the current record-holder (Cassius, 5.5 m *C. porosus* resident at Green Island, Queensland, Australia) as the largest living wild-caught crocodile in captivity.

The response that I found in the Philippines to Lolong was reassuring. He is undoubtedly a celebrity and source of national pride. This seems at odds with the reputation that crocodiles typically have in the Philippines, and from that perspective alone Lolong appears to have the potential to change some attitudes towards crocodiles, particularly the embattled endemic Philippine crocodile (*C. mindorensis*). However, calls for Lolong to be released for welfare reasons are likely misplaced because, national celebrity or not, people usually do not tolerate crocodiles with such sinister reputations swimming around their homes. The attitude of Bunawan officials is that Lolong was not captured, but rather rescued from being poisoned. He now has considerable economic and social value to the province, and if motivation to channel this value back into protection of Agusan Marsh remains high then his capture may have been fortuitous on several levels. Agusan Marsh is clearly important and relatively pristine crocodile habitat, and from the limited photographic evidence I was shown Lolong is not the only exceptionally large crocodile to be found there.

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Vietnam

CROCODILE PRICES DROP. Crocodile farmers in the Mekong Delta provinces of Kien Giang and Ca Mau are reportedly facing financial losses as outbreaks of disease and a weak market affecte sales. The selling price for crocodiles has dropped 20% over the last year to $5.70/kg, yet the price of hatchlings remains relatively high. The local agriculture authority reported that many farms had developed independently, without input from authorities or experts. The authority was thus unable to assist farmers in finding markets, and can only assist farms that are officially registered to raise crocodiles in standardised conditions.

Source: Viet Nam News, 19 December 2011 (http://vietnamnews.vnagency.com.vn/Agriculture/218827/crocodile-farmers-face-losses.html).

Malaysia

PLASTIC LITTER KILLS CROCODILES. Since 1989, more than 50 crocodiles at the Crocodile and Recreation Park in Ayer Keroh have died after ingesting non-digestible litter, thrown by visitors. In most cases, post-mortems revealed the crocodiles had died of severe lung inflammation, caused by the consumption of plastic bags.

Despite the presence of signs, litter (eg bottles, food wrappers/containers, clothing, plastic bags) is still thrown at the crocodiles, mainly in an effort to make them move. Death after ingestion of litter is not always immediate, but may take up to several years. The park receives about 200,000 visitors every year, with up to 2500 visitors per day during school and public holidays.

Source: Hariz Mohd, New Straits Times, 17 December 2011 (http://www.nst.com.my/local/general/plastic-litter-killing-crocs-in-reptile-park-1.20415)

Thailand

ESCAPED CROCODILE BITES MAN. Recent flooding in Thailand are the worst experienced by country in 50 years, with vast areas of the central plains and the northern suburbs of Bangkok inundated. The floodwaters also inundated several crocodile farms, allowing many animals to escape and be swept to Bangkok's northern suburbs. A 1.5-2 m long "escapee" bit a 29-year-old man wading through chest-high floodwaters in the Lak Si District of Bangkok, leaving him with a wound requiring 100 stitches. Thailand's Department of Fisheries led efforts to capture escaped crocodiles, or in cases where this was not possible, to kill the animals. Crocodile catchers, known locally as "kraetong", have even employed electro-shock equipment to subdue crocodiles.

Sources: Asia Pacific News, 4 November 2011 (http://www.monstersandcritics.com/news/asiapacific/news/article_1673194.php/Crocodile-attacks-man-in-Bangkok-floodwaters); International Business Times, 28 October 2011 (http://au.ibtimes.com/articles/239143/20111028/catching-crocodiles-escaped-bangkok-floods-thailand-crocodile.htm).

Science

Recent Publications

Stoker, C., Repetti, M.R., García, S.R., Zayas, M.A., Galoppo, G.H., Beldoménico, H.R., Luque, E.H. and Muñoz-de-Toro, M. (2011). Organochlorine compound residues in the eggs of broad-snouted caimans (*Caiman latirostris*) and correlation with measures of reproductive performance. Chemosphere 84: 311-317.

Abstract: Organochlorine compounds (OCCs), like pesticides (OCPs) and polychlorinated biphenyls (PCBs), are persistent lipophilic chemicals classified as endocrine-disruptors. *Caiman latirostris* inhabits wetlands throughout north-eastern Argentina and may accumulate OCCs. The aims of this study were to determine OCC residues in the eggs of *C. latirostris* and to correlate OCC burden with clutch size, hatching success and hatchling survival as measures of reproductive performance. Fourteen caiman clutches were harvested from sites with different degrees of anthropogenic intervention on wetlands surrounding Paraná River tributaries. Two to four eggs by clutch were used to quantify OCCs. OCP residues were found in all clutches. The principal contributors to the OCPs burden were the DDT family (range BDL-153.0 ng g^{-1} lipid) and oxychlordane (range BDL-34.3 ng g^{-1} lipid). PCBs were present in 92.9% of the clutches (range BDL-136.6 ng g^{-1} lipid). Both higher concentrations and higher diversity of pesticides, including endosulfan sulfate, were found in the nests harvested close to croplands. A negative correlation

was found between clutch size and ∑OCCs (p= 0.02, Pearson r= 0.53, r^2= 0.28), mainly due to the ∑OCPs (p= 0.04, Pearson r= 0.54, r^2= 0.30). Since egg OCCs concentrations predict maternal burden, present findings suggest that higher OCCs exposure could lead to smaller clutches. Although, other factors like mother age could influence clutch size. Additionally, as caimans are a long-lived and non-migratory species, the maternal OCCs burden reflects the environmental status throughout their home range; thus, caiman eggs could be useful as a biomonitor of local contamination.

Scheyer, T.M. and Desojo, J.B. (2011). Palaeohistology and external microanatomy of rauisuchian osteoderms (Archosauria: Pseudosuchia). Palaeontology (doi: 10.1111/j.1475-4983.2011.01098.x).

Abstract: The presence of postcranial dermal armour is plesiomorphic for Archosauria. Here, we survey the external microanatomy and histology of postcranial osteoderms (i.e. dorsal paramedian and caudal osteoderms) of rauisuchians, a widely distributed assemblage of extinct predatory pseudosuchians from the Triassic. The osteoderms of eight rauisuchian taxa were found to be rather compact bones, which usually lack significant bone remodelling or large areas of cancellous bone. The presence of highly vascularized woven or fibrolamellar bone tissue deposited in the core areas indicates higher growth rates during earlier life stages, whereas a more compact parallel-fibred bone matrix indicates reduced growth rates in later development. This pattern of change corroborates earlier studies on long bone histology. With the exception of a bone tissue found in the sample of *Batrachotomus kupferzellensis*, which might be the result of metaplastic ossification, the general mode of skeletogenesis is comparable with intramembraneous ossification. The lack of cancellous bone tissue and remodelling processes associated with bone ornamentation, as well as the predominantly intramembraneous mode of ossification, indicates that rauisuchian osteoderm formation differs profoundly from that of the osteoderms of the only extant pseudosuchian lineage, the crocodylians.

Merchant, M., Juneau, K., Gemillion, J., Falconi, R., Doucet, A. and Shirley, M.H. (2011). Characterization of serum phospholipase A_2 activity in three diverse species ofWest African crocodiles. Biochemistry Research International (doi :10.1155/2011/925012).

Abstract: Secretory phospholipase A_2, an enzyme that exhibits substantial immunological activity, was measured in the serum of three species of diverse West African crocodiles. Incubation of different volumes of crocodile serum with bacteria labeled with a fluorescent fatty acid in the sn-2 position of membrane lipids resulted in a volume-dependent liberation of fluorescent probe. Serum from the Nile crocodile (*Crocodylus niloticus*) exhibited slightly higher activity than that of the slender-snouted crocodile (*Mecistops cataphractus*) and the African dwarf crocodile (*Osteolaemus tetraspis*). Product formation was inhibited by BPB, a specific PLA2 inhibitor, confirming that the activity was a direct result of the presence of serum PLA2. Kinetic analysis showed that *C. niloticus* serum produced product more rapidly than *M. cataphractus* or *O. tetraspis*. Serum from all three species exhibited temperature-dependent PLA2 activities but with slightly different thermal profiles. All three crocodilian species showed high levels of activity against eight different species of bacteria.

Gonzalez-Jauregui, M., Valdespino, C., Salame-Méndez, A., Aguirre-León, G. and Rendón-vonOsten, J. (2011). Persistent organic contaminants and steroid hormones levels in Morelet's crocodiles from the southern Gulf of Mexico. Archives of Environmental Contamination and Toxicology (doi: 10.1007/s00244-011-9716-5).

Abstract: Effects of endocrine disruptors on reproductive variables of top predators, such as alligators and crocodiles, have long been cited. Due to their long life span, these predators provide us with historic contaminant annals. In this study we tried to test whether lifestyle (free-ranging vs. farm animals) and reproductive age of Morelet's crocodiles in Campeche, Mexico, affect the bioaccumulation of organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs). Subsequently, we tested to see whether their concentration was related to steroid hormones (testosterone and estradiol-17β) levels once normal cyclic hormone variation and reproductive age had been taken into account. From the group of contaminants considered (analyzed as families), only frequency of hexachlorocyclohexanes (∑HCH) and ∑PCB permitted analyses. Whereas there was a greater concentration of ∑HCH bioaccumulated by free-ranging crocodiles, ∑PCB was found in equal quantities in free-ranging and farm animals. No difference was observed in relation to reproductive age for any of the contaminants. However, ∑PCB concentrations were related to testosterone levels among female crocodiles. This androgenic effect of ∑PCB has not been reported previously. Because testosterone promotes aggressive behavior in vertebrates, excessive aggression during the estrous season, or when female crocodiles should be caring for their young, could result in reproductive failure in Morelet's crocodiles and potential long-term decline of the population.

Azevedo, F.C.C. and Verdade, L.M. (2011). Predator-prey interactions: jaguar predation on caiman in a floodplain forest. Journal of Zoology (doi: 10.1111/j.1469-7998.2011.00867.x).

Abstract: Advances in the understanding of ecological factors determining predator-prey interactions have provided a strong theoretical background on diet preferences of predators. We examined patterns of jaguar predation on caiman in southern Pantanal, Brazil. We investigated factors affecting predation rates and vulnerability of caiman to predation by jaguars. We recorded 114 caiman mortality incidents. Predation accounted for 62.3% (n= 71) of all caiman found dead, while other causes of mortality (nonpredation) accounted for 37.7% (n= 43). We found that jaguars prey on a broad size range of caiman body and caiman predation was influenced

by distance to forests. During dry seasons, 70% (n= 49) of deaths were due to predation, while 30% (n= 21) were due to nonpredation causes. However, we found no significant relationship between annual and monthly killings of caiman and rainfall totals by year and month (r= 0.130, r= –0.316). The annual flooding regime may be a more important factor influencing prey selection by jaguars. Although neotropical crocodilians are relatively well studied, their interactions with jaguars have been mostly ignored and should be prioritized in future studies.

Nifong, J.C. and Frick, M.G. (2011). First record of the American alligator (*Alligator mississippiensis*) as a host to the sea turtle barnacle (*Chelonibia testudinaria*). Southeastern Naturalist 10(3): 557-560.

Abstract: *Chelonibia testudinaria* (Sea Turtle Barnacle) and other closely related barnacle species of the genus *Chelonibia* are known to utilize a variety of organisms for their attachment substrate. These include the calcified exoskeleton of marine crustaceans and chelicerids, the epidermis of manatees, and the carapace regions of all extant sea turtle species. Here, we present the first records of an *Alligator mississippiensis* (American Alligator; Alligatoridae) as a host for *C. testudinaria*.

Lance, V.A., Elsey, R.M., Trosclair III, P.L. and Nunez, L.A. (2011). Long-distance movement by American alligators in Southwest Louisiana. Southeastern Naturalist 10(3): 389-398.

Abstract: As part of an ongoing study on growth and sexual maturation of *Alligator mississippiensis* (American Alligator) on Rockefeller Wildlife Refuge, LA, 3601 specimens, ranging in total length from 28 to 361 cm, were captured from June 2000 through August 2004. Additionally, 70 alligators were collected opportunistically as part of a teaching exercise in August 2005, and 248 more were collected in 2006 (and one in January 2007) as part of a study evaluating the effects of Hurricane Rita on alligators. Representative samples from size classes greater than 60 cm were collected in most months of the year between 2000 and 2004. Each animal was tagged, measured, sexed, and released immediately at the site of capture. A large number of these marked alligators were recaptured outside the refuge boundaries during annual alligator hunts in September. Of the 286 recaptured alligators, 214 were males, 68 were females, and four were of undetermined sex. From each recaptured alligator, total body length and date of recapture were recorded, and minimum distance from initial capture site estimated. From these preliminary data, we calculated the time interval between captures, and plotted minimum distance moved. The number of days between first capture and recapture ranged from 29 to 3336 days (9.1 years). Distance moved from initial capture site to final capture site ranged from 0.3 to 90.2 km. Eleven alligators moved between 30.0 and 39.9 km, and eight moved ≥40 km. Six of these moved between 40.0 and 49.9 km, and the others moved 87.4 and 90.2 km. These results greatly extend previous estimates of long-distance movement by alligators and demonstrate that both sub-adult and sexually mature animals move considerable distances. These data also showed that smaller alligators moved greater distances than larger alligators (P= 0.0002), and that the longer the time between captures, the greater the distance moved (P< 0.0001).

Guillory, G., Hardaway, C.J., Merchant, M.E. and Sneddon, J. (2011). Determination of selected metals in alligator (*Alligator mississippiensis*) tissues by inductively coupled plasma-optical emission spectrometry. Instrumentation Science & Technology 39(4): 368-373.

Abstract: The results presented in this preliminary study show the concentrations of selected metals in the muscle and bone tissues from the tail of an alligator (*Alligator mississippiensis*) as determined using inductively coupled plasma-optical emission spectrometry (ICP-OES). Cadmium and lead were not detected above the approximate detection limit of 0.5 µg/g for these two metals by ICP-OES, in either meat or bone tissues. Concentrations (µg/g) (mean ±standard deviation, range) for copper were 8.8 ± 3.8, 6.5-13.1 (meat), and 6.2 ± 3.5, 3.6-10.2 (bone); for iron were 41.9 ± 16.2, 28.8-59.9 (meat), and 26.4 ± 4.4, 21.3-29.0 (bone); and for zinc were 52.8 ± 7.4, 48.0-61.4 (meat) and 42.7 ± 9.0, 34.9-53.2 (bone). The results of copper, iron, and zinc levels were not considered to be potentially toxic to the alligator.

Srikulnath, K., Thongpan, A., Suputtitada, S. and Apisitwanich, S. (2011). New haplotype of the complete mitochondrial genome of *Crocodylus siamensis* and its species-specific DNA markers: distinguishing *C. siamensis* from *C. porosus* in Thailand. Molecular Biology Reports (doi: 10.1007/s11033-011-1263-7).

Abstract: Based on molecular phylogeny of available complete mitochondrial DNA (mtDNA) genome sequences reveals that *Crocodylus siamensis* and *C. porosus* are closely related species. Yet, the sequence divergence of their mtDNA showed only a few values under conspecific level. In this study, a new haplotype (haplotype2, EF581859) of the complete mtDNA genome of Siamese crocodile (*C. siamensis*) was determined. The genome organization, which appeared to be highly similar to haplotype1 (DQ353946) mtDNA genome of *C. siamensis*, was 16,814 bp in length. However, the sequence divergence between the two genomes differed by around 7-10 and 0.7-2.1% for the haplotype1 between *C. siamensis* and *C. porosus* (AJ810453). These results were consistent with the phylogenetic relationship among the three genomes, suggesting that *C. siamensis* haplotype1 mtDNA genome might be the hybrid or the intraspecific variation of *C. porosus*. On the other hand, our specimen was found to be a true *C. siamensis*. Simultaneously, the 7 species-specific DNA markers designed based on the distinctive site between haplotype2 mtDNA sequences of *C. siamensis* and haplotype1 mtDNA sequence of *C. siamensis*-*C. porosus* were successfully used to distinguish *C. siamensis* from *C.*

porosus. These effective markers could be used primarily for rapid and accurate species identification in population, ecology and conservation studies.

Boggs, A.S.P., Hamlin, H.J., Lowers, R.H. and Guillette, L.J. (2011). Seasonal variation in plasma thyroid hormone concentrations in coastal versus inland populations of juvenile American alligators (*Alligator mississippiensis*): Influence of plasma iodide concentrations. General and Comparative Endocrinology (doi:10.1016/j.ygcen.2011.09.014).

Abstract: Thyroid hormones, essential for normal growth and health, are associated with changes in temperature, photoperiod, and reproduction. Iodide, a necessary element for thyroid hormone production, varies in diet, and is more abundant in estuarine environments, which could alter thyroid hormone variation. However, associations between thyroid hormone concentrations in animals from marine versus freshwater environments, which could become more pertinent with rising sea levels associated with global climate change, are not well studied. To determine the importance of dietary iodide in seasonal variation of plasma thyroid hormone concentrations, we analyzed seasonal variation of thyroxine (T4) and triiodothyronine (T3) concentrations in juvenile alligators from an estuarine habitat (Merritt Island National Wildlife Refuge; MI) and a freshwater habitat (Lake Woodruff National Wildlife Refuge; LW) and compared these results to plasma inorganic iodide (PII) concentrations. Alligators from MI did not display seasonal variation in plasma T4, but exhibited a seasonal pattern in plasma T3 concentrations similar to alligators from LW. Plasma thyroid hormone concentrations were consistently higher at MI than at LW. PII concentrations were correlated with plasma T4 and T3 concentrations in juvenile alligators from LW but not MI. The data on plasma T4 and T3 concentrations suggest altered iodide metabolism in estuarine alligators. Differences in thyroid hormone concentrations between the populations could be due to differences in dietary iodide, which need to be further evaluated.

Woodward, H.N., Horner, J.R. and Farlow, J.O. (2011). Osteohistological evidence for determinate growth in the American alligator. Journal of Herpetology 45(3): 339-342.

Abstract: An external fundamental system (EFS) is a form of bone microstructure present in the outermost cortex of long bones in animals that have attained skeletal maturity. It indicates an effective cessation of any significant periosteal growth (i.e., growth in circumference or girth). Although an EFS has been noted in several reptile taxa, the idea that reptiles grow continually throughout their lives remains popular. Examination of femoral bone microstructure from captive American Alligators (*Alligator mississippiensis*) reveals parallel-fibered tissue terminating periosteally in an EFS, thus confirming determinate growth in another reptile taxon. The results of this study have several important implications for both modern and fossil tetrapods: first, because many birds, nonavian dinosaurs, pterosaurs, and basal pseudosuchians all produce an EFS, it can be concluded that determinate growth is a shared characteristic of Archosauria; second, because the captive alligators were not senescent, an EFS should not be associated with "old age" when interpreting growth histories of extinct animals; third, if no EFS is present, this should not immediately suggest indeterminate growth but rather that skeletal maturity was not attained prior to death. In addition, this study highlights the need for more osteohistological studies to establish exactly how widespread determinate growth is within both extinct and extant members of Sauropsida, because this form of growth may be the rule rather than the exception.

Jacobs, K., Goy, S.K. and Dzialowski, E.M. (2011). Morphology of the embryonic and hatchling American alligator ductus arteriosi and implications for embryonic cardiovascular shunting. Journal of Morphology (doi: 10.1002/jmor.11015).

Abstract: The ductus arteriosi (DA) are embryonic blood vessels found in amniotic vertebrates that shunt blood away from the pulmonary artery and lungs and toward the aorta. Here, we examine changes in morphology of the right and left DA (LDA), and right and left aorta (LAo) from embryonic and hatchling alligators. The developing alligator has two-patent DA that join the right and LAo. Both DA exhibit a muscular phenotype composed of an internal smooth muscle layer (2-4 cells thick). At hatching, the lumen diameter of both DA decreases as the vessels begin to close within the first 12 h of posthatch life. Between day 1 and day 12 posthatching, the vessel becomes fully occluded with endothelial and smooth muscle cells filling the lumen. A number of DA from hatchlings contained blood clots along their length. The lumen of the full-term alligator DA is reduced in comparison with the full-term chicken DA. The developing alligator embryo has an additional right-to-left shunt pathway in the LAo arising from the right ventricle. The embryonic LAo diameter is twice the diameter of either the right DA or LDA, providing a lower resistance pathway for blood leaving the right ventricle. On the basis of these findings, we propose that the paired DA of the embryonic alligator have a reduced role in the embryonic right-to-left shunt of blood from the right ventricle when compared with the avian DA.

Ziegler, T., Sommerlad, R., Braß, W., van der Straeten, K., Karbe, D. and Rauhaus, A. (2011). Wie die Philippinenkrokodile an den Rhein kamen. Zeitschrift des Kölner Zoos 3: 119-141.

Summary: The husbandry and keeping of crocodiles has a long lasting tradition in the Aquarium of the Cologne Zoo, which has been proven by multiple breeding successes of Nile crocodiles (*Crocodylus niloticus*) and dwarf caimans (*Paleosuchus palpebrosus*) in the past four decades. Facing the first transfer of Philippine crocodiles (*Crocodylus mindorensis*) in EAZA (European Association of Zoos and Aquariums) Zoos, Cologne Zoo decided to engage in a conservation breeding program of this critically endangered species. The

EAZA import of Philippine crocodiles into Europe finally was enabled by contracts between the respective European partner zoos with the Philippine government and the Krokodille Zoo in Eskilstrup, Denmark, who was responsible for the crocodile transfer. With the keeping of Philippine crocodiles, which are still owned by the Philippine government, the European partner zoos obligated themselves to support the Mabuwaya Foundation in San Mariano on the Philippine island of Luzon, thus connecting *ex situ* with *in situ* crocodile conservation activities. Because Nile crocodiles still occupied the crocodile exhibit in the Aquarium of the Cologne Zoo at the time of the import of the Philippine crocodiles, an in total 315 x 762 cm measuring, threefold divisible enclosure with additional water space underneath the land parts was built for the young Philippine crocodile pair behind the scenes of the Aquarium. When in May 2010 the Nile crocodiles were relocated to the new tropical house "Hippodom", we measured, planned and invited tenders from July to October 2010, and subsequently started with the renovation of the old public crocodile exhibit in the Aquarium of the Cologne Zoo. By doing so, the old public crocodile exhibit was expanded by including a neighbouring terrarium, and former parts of the visitor's area were added as two additional land parts. Due to a current confiscation of endangered yellowbanded Philippine water monitor lizards (*Varanus cumingi*), which had to be urgently placed in zoos, a facility for this species became integrated in the new Philippine exhibit at short notice. Instead of the old visitor's barrier the new monitor lizard and crocodile exhibits are visible through a 22 m long and 2 m high new glass barrier, consisting of 10 double glazed windows. To keep the Philippine crocodiles, which tend to aggressive behaviour in captivity, species-appropriate and secure, two partitions were included in the public exhibit: On the one hand to separate male and female, on the other hand to subdivide the female enclosure, so that the keepers always have secured access to a crocodile-free part of the enclosure while cleaning. On 2nd May 2011 the currently only Philippine crocodiles in Germany - the 161 cm long and 16.0 kg heavy male Pinoy and the somewhat smaller, 153 cm long and 11.3 kg heavy female Mindo - entered their new ca. 62 m^2 large public exhibit in the Aquarium of the Cologne Zoo, which was opened several days later. Apart from information about the first EAZA import of Philippine crocodiles to Europe and details on the planning and building, both of the off-exhibit keeping and public exhibit in the Cologne Aquarium, we provide information on the biology of the Philippine crocodile and on our first experiences with the husbandry of this species in the present article. The Philippine crocodiles kept in Cologne and remaining European EAZA zoos are to be establishing a European conservation breeding program of this critically endangered species.

Charruau, P. (2011). Microclimate of American crocodile nests in Banco Chinchorro Biosphere Reserve, Mexico: Effect on incubation length, embryos survival and hatchlings sex. Journal of Thermal Biology 37: 6-14. (doi:10.1016/j.jtherbio.2011.10.010).

Abstract: Crocodilians have temperature-dependent sex determination (TSD) in which incubation temperature determines sex of embryo. Global warming is expected to alter hatchling sex ratio, leading to the extinction of small populations. Regional climate influence on crocodile nest microclimate and hatchlings characteristics is poorly known. Here, microclimate in natural nests of American crocodile (*Crocodylus acutus*) and its relation with incubation length, hatchling sex and nesting success was studied in Banco Chinchorro Biosphere Reserve (Mexico) from 2007 to 2010. Temperature and relative humidity in different locations within and outside of nests were registered by data loggers. Incident solar radiation above nest was calculated from hemispheric photographs. Incubation length, proportion of hatchling reaching complete development and hatchling sex were determined at hatching. Nest temperatures exhibited a cyclic daily fluctuation due to solar radiation, which is the major heat source for nests. Clutch temperature was relatively stable and its daily amplitude was negatively correlated with clutch depth and size. Rainfall was the major source of clutch temperature decrease. Clutch and metabolic temperatures increased significantly during incubation. A small sample size failed to demonstrate a statistical relationship between length of incubation and mean clutch temperature. Proportion of embryos reaching complete development depended on maximum and minimum clutch temperature, maximum daily amplitude of clutch temperature and maximum decrease in clutch temperature on a period ≤4 day. Results confirmed a Female-Male-Female TSD pattern for *C. acutus*, with 31 and 32.5°C as possible pivotal temperatures. Population and hatchling sex ratios were male-biased and fate of crocodiles of Banco Chinchorro could depend on the magnitude of temperature increase in the future.

Marschang, R.E. (2011). Viruses infecting reptiles. Viruses 3: 2087-2126.

Abstract: A large number of viruses have been described in many different reptiles. These viruses include arboviruses that primarily infect mammals or birds as well as viruses that are specific for reptiles. Interest in arboviruses infecting reptiles has mainly focused on the role reptiles may play in the epidemiology of these viruses, especially over winter. Interest in reptile specific viruses has concentrated on both their importance for reptile medicine as well as virus taxonomy and evolution. The impact of many viral infections on reptile health is not known. Koch's postulates have only been fulfilled for a limited number of reptilian viruses. As diagnostic testing becomes more sensitive, multiple infections with various viruses and other infectious agents are also being detected. In most cases the interactions between these different agents are not known. This review provides an update on viruses described in reptiles, the animal species in which they have been detected, and what is known about their taxonomic positions.

Ardila-Robayo, M.C., Martínez-Barreto, W., Suárez-Daza, R.M. and Moreno-Torres, C.A. (2012). La Estación Roberto Franco (EBTRF) y el Cocodrilo del Orinoco en Colombia:

contribución a su biología y conservación. Latin American Journal of Conservation.

Abstract: The main goal of the present paper is to show information that has been presented in some national and international forums, on the experience through several years at Roberto Franco Biological Station of Facultad de Ciencias of Universidad Nacional de Colombia. This station have a very particular history and some aspects of it history have been described in several publications. We show, in a concrete and clear form, what is the contribution of Roberto Franco Biological Station as responsible for a captive population of endangered species, *Crocodylus intermedius*, which were historically hunted indiscriminately. We documented the progress in various research projects in which not only involved the station and some of its members as well as many interns, volunteers and professionals that have relied on this fauna to also develop their work or subjects of their degree programs as biology, veterinary medicine, animal science, environmental engineering, and ecology.

Jandaruang, J., Siritapetawee, J., Thumanu, K., Songsiriritthigul, C., Krittanai, C., Daduang, S., Dhiravisit, A. and Thammasirirak, S. (2011). The effects of temperature and pH on secondary structure and antioxidant activity of *Crocodylus siamensis* hemoglobin. The Protein Journal (doi: 10.1007/s10930-011-9372-7).

Abstract: *Crocodylus siamensis* hemoglobin (cHb) was purified by gel filtration chromatography and visualized by SDS-PAGE. Effects of temperature and pH on secondary structure and conformation changes of cHb were studied using circular dichroism spectropolarimeter and fourier transform infrared spectrophotometer. The secondary structure of intact cHb was mainly α-helices. cHb was not heat stable when heated at 65°C and cooled down to original temperature, indicating the irreversible unfolding process. The stability of cHb at different pH ranging from 2.5 to 10.5 was determined. The maximum value of the α-helix content was found at pH 3.5 and tended to decrease at strong acid and strong base. The antioxidant activities of heat treated cHb and cHb in solution with pH range 2.5 to 10.5 were tested by DPPH radical scavenging assay. cHb at pH 4.5, having highest β-turn structure, showed highest radical scavenging activity. In contrast to pH, heat had no effect on antioxidant activity of cHb.

Platt, S.G., Rainwater, T.R., Thorbjarnarson, J.B. and Martin, D. (2011). Size estimation, morphometrics, sex ratio, sexual size dimorphism, and biomass of *Crocodylus acutus* in the coastal zone of Belize. Salamandra 47(4): 179-192.

Abstract. We used morphometric data from 151 *Crocodylus acutus* captured in the Coastal Zone of Belize to develop predictive models for deducing body size (total length [TL] and snout-vent length [SVL]) from measurements of single attributes (dorsal cranial length [DCL], cranial width [CW], snout length [SL] and width [SW], body mass [BM], and rear foot length [RFL]), quantify sexual size dimorphism, examine ontogenetic changes in cranial morphology, and estimate standing crop biomass of crocodiles on an offshore atoll. Strong positive allometric relationships were found between measurements of body length and other morphometric attributes, and provide a reliable means to estimate body length from tracks, skulls, and body parts. The maximum DCL:CW ratio of 2.4 was attained at a body size that coincided with a dietary shift from invertebrates to larger vertebrate prey. The SL:SW ratio of *C. acutus* partially overlapped that of *C. moreletii*, and consequently this attribute was not useful for distinguishing these two morphologically similar, sympatric species. The mean DCL:TL ratio was 0.15 and remained constant across body sizes ranging from hatchlings to large adults. Both overall and adult sex ratio (female:male) were not significantly different from parity. The mean SVL of males (111.3 ± 20.7 cm) was significantly greater than that of females (101.0 ± 6.2 cm). A compressed sexual size dimorphism index (SDI) of 2.10 was calculated for *C. acutus* in coastal Belize. *Crocodylus acutus* in coastal Belize appear to attain a smaller body size than reported for other populations. Standing crop biomass of *C. acutus* in the Turneffe Atoll was estimated to be 0.92 kg/ha.

Charruau, P., Cedeño-Vázquez, J.R., Villegas, A. and González-Cortés, H. (2011). Tasas de crecimiento del Cocodrilo Americano (*Crocodylus acutus*) en estado silvestre en la Península de Yucatán, México. Latin American Journal of Conservation 1 (2): 63-72.

Abstract: We present the first data on the growth rates of wild American Crocodiles (*Crocodylus acutus*) in the Yucatan Peninsula. The rate of grow for both length and mass vary considerably between individuals, from minimums of 0.008 cm/day and 0.00 g/day to maximums of 0.121 cm/day to 60.00 g/day. Growth in mass is relatively low in young individuals and increases rapidly high rates in subadults, then decreasing to low rates in adults. Length growth rates tend to decrease as crocodiles reach larger sizes, being higher during the first year of life with a mean of 0.067 cm/day, then growth declines in juveniles and subadults with means of 0.038 and 0.058 cm/day respectively, and growth of individuals in the adult class decreases substantially to 0.012 cm/day.

Cedeño-Vázquez, J.R. and Pérez-Rivera, S.D. (2011). El Cocodrilo de Pantano (*Crocodylus moreletii*) en Laguna Esmeralda, Quintana Roo, México. Latin American Journal of Conservation 1(2): 91-98.

Abstract: We conducted spotlight surveys between February 2005 and July 2006 in five lagoons of the Esmeralda lagoon system to estimate abundance and population structure of Morelet's Crocodile. A total of 287 crocodiles were sighted along 8.3 km of survey routes. Encounter rates ranged from 6.1 to 44.4 ind/km, and adults were the most abundant (33.5%), followed by juveniles (13.6%), while hatchlings (<30 cm TL) and subadults were less represented (8.2% and 7.5%, respectively). The sex ratio of this population (n= 42;

7 hatchling were excluded) does not differ from parity (1:1). Our findings indicate that Morelet's Crocodile population is in a good condition in the study area. This study provides baseline information to initiate use of the species, following a program of management and monitoring to ensure the persistence of this healthy population in the long-term.

Cedeño-Vázquez, J.R., González-Ávila, F. and Castro-Pérez, J.M. (2011). Condición corporal del cocodrilo de pantano (*Crocodylus moreletii*) en el Río Hondo, Quintana Roo, México. Quehacer Científico en Chiapas 1(11): 19-26.

Abstract: Body condition indices (CI) are useful tools as indicators of the health, nutrition, and life history of the individuals in a population. Healthy individuals with high energy reserves have more probabilities to breed; therefore, good body conditions are essential in order to preserve populations and the ecosystem functioning. Morelet's crocodile (*Crocodylus moreletii*) is a key species for the stability of the ecosystem. However, studies about the health of its populations are quite scarce. The aim of this research was to determine the CI of the population of *C. moreletii* in the Hondo River, through the application of Fulton's "K" condition factor (CF). During two survey periods (April-September 2002, and June 2009 to February 2010), we conducted spotlight counts aboard a 4.5 m-long aluminum boat in 6 sections of the river. We analyzed 200 crocodiles, most of which (n= 177) had a good body condition (mean K = 41.63), which denotes a healthy population. ANOVA tests applied to mean CF values revealed significant differences ($P<0.05$) between survey sections, and age classes, but no significant differences between males and females ($P>0.05$) in both periods. Monitoring of CF in the *C. moreletii* population is important for the improvement of the conservation and management actions for the species and its habitat, and must be considered in future research.

Zeng, C., Ye, Q. and Fang, S. (2011). Establishment and cryopreservation of liver, heart and muscle cell lines derived from the Chinese alligator (*Alligator sinensis*). Chinese Science Bulletin 56(24): 2576-2579.

Abstract: The Chinese alligator, *Alligator sinensis*, is a critically endangered species. A conservation project of gene resources for an endangered species first involves the preservation of organs, tissues, gametes, genomic DNA libraries and cell lines. The present study is the first to establish and cryopreserve cell lines of liver, heart and muscle tissues from the Chinese alligator. The study revealed that there was a large discrepancy in cell migration time in primary cultures among liver (11-12 d), heart (13-14 d) and muscle (17-18 d) tissue pieces. The differences in time in primary cell culture suggested that it was relatively easy to build visceral-derived cell lines for reptiles. Biological analysis showed that the population doubling time for thawed cells was approximately 36 h. Karyotyping revealed that the frequency of Chinese alligator cells showing chromosome number as 2n= 32 was 88.-93.4%. Chinese alligator cell lines established here provide a vital resource for research and are likely to be useful for protection of this rare and critically endangered species. Furthermore, the establishment of these methods may supply technical and theoretical support for preserving genetic resources at the cellular level for other reptile species.

Serna-Lagunes, R., Díaz-Rivera, P. and Cota-Fernández, J.M. (2011). Characterization of morphological traits of commercial interest in the Morelet's crocodile (*Crocodylus moreletii*). Tropical and Subtropical Agroecosystems 13: 357-364.

Abstract: *Crocodylus moreletii* is a species of commercial interest based on its skin. In this study, five morphological traits of commercial interest were characterized in 125 captivity-raised specimens of *C. moreletii* from four populations (Puente Chilapa, Gutiérrez Zamora, Villa Juárez and Puerto Vallarta). A canonical discriminant analysis (CDA) was used to differentiate the populations according to their morphological traits, a cluster analysis (CA) was used to infer which populations had the largest total length (TL), and a covariance analysis (ANCOVA) was used to assess the allometry and detect which population was different in terms of TL. The CDA showed no significant effects, suggesting that the morphological traits were similar among populations; the CA grouped two populations which had the largest body size; the ANCOVA revealed a significant correlation between morphological traits and detected a TL effect significantly lower in males and females from Puente Chilapa, in comparison with the other three populations. In conclusion, the males from Gutiérrez Zamora and the females from Villa Juárez were morphologically outstanding in terms of TL, and they would be the right crocodiles to establish a breeding nucleus in order to obtain offspring with their phenotypic characteristics.

Tellez, M. and Paquet-Durand, I. (2011). Nematode infection of the ventral scales of the American crocodile (*Crocodylus acutus*) and Morelet's crocodile (*Crocodylus moreletii*) in southern Belize. Comparative Parasitology 78(2): 378-381.

Abstract: Examples of nematodes parasitizing the ventral scales of *Crocodylus acutus* and *Crocodylus moreletii* in southern Belize were observed via health assessments performed on crocodiles at the American Crocodile Education Sanctuary in Punta Gorda, Belize, in August 2009. Indirect identification was based on physical imprints of the parasite on the epidermis, and zigzag scars caused by movement and egg discharge from the skin into the surrounding environment. These observations in Belize are similar to those of documented cases of *Paratrichosoma* Ashford and Muller 1978 (Nematoda: Trichosomoididae) found on the ventral scales of crocodiles in Mexico, Asia, and Australia.

Machha, V., Spencer, P. and Merchant, M. (2011). Effects of leukocyte extract from the American Alligator (*Alligator*

mississippiensis) on antibiotic-resistant bacteria. The Open Zoology Journal 4: 9-13.

Abstract: Treatment of clinical isolates of human pathogenic bacteria, which were known to be resistant to multiple commonly-used antibiotics, with refined leukocyte extracts from the American alligator (A*lligator mississippiensis*) resulted in a time- and concentration-dependent inhibition of bacterial proliferation. The alligator leukocyte extract exhibited the strongest antibacterial effect on *Pseudomonas aeruginosa* followed by *Enterococcus faecium* and then *Klebsiella pneumonia*. The antibacterial activities were acid-soluble, heat-stable at 70°C for one h, sensitive to protease treatment, and did not require divalent metal ions for antibacterial activity. Collectively, these data strongly suggest that the molecule(s) responsible for the observed antibacterial activities are small, cationic antimicrobial peptides.

Leslie, A.J., Lovely, C.J. and Pittman, J.M. (2011). A preliminary disease survey in the wild Nile crocodile (*Crocodylus niloticus*) population in the Okavango Delta, Botswana. Journal of the South African Veterinary Association 82(3): 155-159.

Abstract: The objective of this study was to conduct a preliminary survey of diseases that might be present in the wild Nile crocodile population in the Okavango Delta, Botswana. Blood samples were collected from crocodiles ranging in size from 34.0 cm to 463.0 cm total length. Samples were examined for blood parasites and underwent a haematological analysis. Before release the crocodiles were examined for various clinical abnormalities. Of the 144 crocodiles examined, none were visibly sick or displayed any signs of disease. No antibodies to *Mycoplasma crocodyli* were detected. *Hepatozoon pettiti* was present in 55.3% of blood smears examined, but there was no significant difference in any of the haematological values between the infected and uninfected crocodiles, and a high prevalence of *Hepatozoon* infection is not uncommon in other species. Only 7.6% of the examined crocodiles were infested with leeches. Further research is required for several of the crocodilian diseases, in particular to elucidate the role of wild crocodilians as reservoirs of infection.

Combrink, X., Korrubel, J.L., Kyle, R., Taylor, R. and Ross, P. (2011). Evidence of a declining Nile crocodile (*Crocodylus niloticus*) population at Lake Sibaya, South Africa : research article. South African Journal 41(2): 145-157.

Abstract: Formerly widespread throughout the water bodies of eastern South Africa, viable Nile crocodile (*Crocodylus niloticus*) populations are now restricted to three disjunct protected areas in KwaZulu-Natal (KZN), Mpumalanga and Limpopo. Growing evidence suggests that protected populations are declining, including the breeding *C. niloticus* population at Lake Sibaya in KZN. Aerial surveys were conducted at Lake Sibaya from 2003-2004 and 2007-2009, spotlight counts in 2003 and intensive nesting surveys in 2003 and 2004. Seven adults were counted during the 2009 aerial survey; an 89% decrease from the 1985 count (62 adults) and a decline of 95-98% of the estimated 1970 adult population. Likewise, in 1970 30 nests were recorded, compared to 3 nests in 2003 and no recorded nests in 2004. The non-hatchling population in 2003 was estimated at 48 individuals and decreased to an estimated 8 in 2009. The neighbouring community perceives crocodiles as a threat to their lives and livestock, and increasing human pressures on *C. niloticus* in the area will probably ensure that the population will not recover naturally. Unless crocodiles are perceived as a useful or somehow beneficial natural resource by the surrounding community,the species faces possible extirpation from Lake Sibaya in the future

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Tkach, V.V. (2011) *Paraoistosomum novaeguineae* n. gen., n. sp. (Digenea) from a New Guinea crocodile: a surprising relative of the enigmatic *Oistosomum caduceus* Odhner, 1902. Journal of Parasitology 97(4): 717-720.

Abstract: *Paraoistosomum novaeguineae* n. gen., n. sp. is described based on specimens from the kidneys of a New Guinea crocodile *Crocodylus novaeguineae* collected in Papua New Guinea. The body shape and the topology of most internal organs of the new species are strongly reminiscent of *Oistosomum caduceus* Odhner 1902, the sole member of *Oistosomum*, a genus of unclear phylogenetic relationships and systematic position described from the Nile crocodile in Sudan in 1902 and never reported since then. At the same time, the new species has a number of significant differences from *Oistosomum caduceus*. Among them are much shorter intestinal ceca, a relatively larger ventral sucker, ovary anterolateral to ventral sucker (posterolateral in *O. caduceus*), vitellaria arranged in 2 clusters of loosely organized follicles at the level of ventral sucker (2 narrow long lateral fields in *O. caduceus*), much longer esophagus, and other characters. Most importantly, the new species has the genital pore situated at the anterior body end adjacent to the oral sucker, whereas *O. caduceus* has the genital pore in front of the ventral sucker. These dramatic differences suggest establishment of a new genus for the species from Papua New Guinea. The anatomy of *P. novaeguineae* n. gen., n. sp. suggests that these genera may not belong to the Plagiorchiidae, the current familial allocation of *Oistosomum*. Scarcity of material and lack of molecular data do not permit clarification of this problem at the present time.

Bonnie Joan Garcia (2011). Skeletochronology Of The American Alligator (*Alligator mississippiensis*): Examination Of The Utility Of Elements For Histological Studies. MScThesis, Florida State University, Tallahassee, Florida, USA.

Abstract: Neontological studies of reptilian growth are important as they provide a proxy allowing investigation of the life history of extinct relatives. As such, finding modern correlates for bone growth and histological types that can then be used in a skeletochronological capacity are important for

unraveling prehistoric mysteries that involve the growth of the extinct relatives of modern taxa. Most skeletochronology studies have focused on the lines of arrested growth, or LAGs, generated in the femur, as femoral size is large enough to study in even small reptiles and round in cross-sectional shape such that growth occurs evenly in all directions in the transverse plane of reference. No single study has yet to section every bone type in the body of an animal. This would allow for exploration of the extent to which other elements preserve the growth record and provide alternative elements to study growth, which may prove useful when the femur is not available. Modern archosaurs such as crocodilians, and in particular the American alligator (*Alligator mississippiensis*), not only allow for not only an interesting modern system but also provide a proxy for the past given their close evolutionary ties to fossil archosaurs such as dinosaurs. With the goal of generating a histological map of elements useful for aging in archosaurs, I conducted a histological analysis of an alligator previously in the care of the Florida Fish and Wildlife Commission was conducted. A representative of every type of bone was sectioned at multiple points and chemical label counts and tissue type characterizations were made. Aside from major long bone elements commonly used in histological studies, other skeletal structures such as ribs and phalanges exhibit areas of excellent LAG deposition that make them potentially useful in skeletochronologic analysis. From this data a "map" of the alligator skeleton was constructed regarding where along skeletal elements researchers are likely to find unobstructed deposition of LAGs. The results of this study elucidate which bones are best suited for analysis, as well as where along those bones information is preserved. Because histological analysis is a destructive technique, this information will allow researchers to make more informed decisions with regards to which skeletal elements to sample, thus reducing the potential for damaging more elements than is necessary. This will also open the possibility to age partial skeletons in which the femur is missing or unavailable for sampling.

Guderley, H. and Seebacher, F. (2011). Thermal acclimation, mitochondrial capacities and organ metabolic profiles in a reptile (*Alligator mississippiensis*). Journal of Comparative Physiology B: Biochemical, Systemic, and Environmental Physiology 181(1): 53-64 (doi: 10.1007/s00360-010-0499-1).

Abstract: Reptiles thermoregulate behaviourally, but change their preferred temperature and the optimal temperature for performance seasonally. We evaluated whether the digestive and locomotor systems of the alligator show parallel metabolic adjustments during thermal acclimation. To this end, we allowed juvenile alligators to grow under thermal conditions typical of winter and summer, providing them with seasonally appropriate basking opportunities. Although mean body temperatures of alligators in these groups differed by approximately 10°C, their growth and final anatomic status was equivalent. While hepatic mitochondria isolated from cold-acclimated alligators had higher oxidative capacities at 30°C than those from warm-acclimated alligators, the capacities did not differ at 20°C. Cold acclimation decreased maximal oxidative capacities of muscle mitochondria. For mitochondria from both organs and acclimation groups, palmitate increased oligomycin-inhibited respiration. GDP addition reduced palmitate-uncoupled rates more in liver mitochondria from warm- than cold-acclimated alligators. In muscle mitochondria, carboxyatractyloside significantly reduced palmitate-uncoupled rates. This effect was not changed by thermal acclimation. The aerobic capacity of liver, skeletal muscle and duodenum, as estimated by activities of cytochrome c oxidase (COX), increased with cold acclimation. At acclimation temperatures, the activities of COX and citrate synthase (CS) in these organs were equivalent. By measuring COX and CS in isolated mitochondria and tissue extracts, we estimated that cold acclimation did not change the mitochondrial content in liver, but increased that of muscle. The thermal compensation of growth rates and of the aerobic capacity of the locomotor and digestive systems suggests that alligators optimised metabolic processes for the seasonally altered, preferred body temperature. The precision of this compensatory response exceeds that typically shown by aquatic ectotherms whose body temperatures are at the mercy of their habitat.

Westaway, M., Thompson, J., Wood, W. and Njau, J. (2011). Crocodile ecology and the taphonomy of early Australasian sites. Environmental Archaeology l6(2): 124-136.

Abstract: Humans and human ancestors have exploited wetland resources for at least two million years. The most significant predators in these landscapes are crocodiles, which leads to two potential taphonomic problems: 1) human-accumulated bones may become intermingled with crocodile-modified bones; and 2) hominins themselves may have been victims of crocodiles. Davidson and Solomon (1990) significantly contributed to this literature through theirsuggestion that a crocodile attack led to the tooth marks on the type specimen of Homo habilis (OH 7) found in Olduvai Gorge, Tanzania. The Australasian tropics were also home to a variety of crocodilian species, crocodile damage to hominin bones being inferred in Trinil and Sangiran, Java. Furthermore, two Pleistocene Australian archaeological sites have stone artefacts in association with crocodile-damaged bone. A referential taphonomic framework is needed to understand the degree and nature of crocodile-hominin interactions on paleolandscapes of Sunda, the ancient Pleistocene landmass incorporating the islands of SE Asia, and Sahul, the Pleistocene landmass of ancient Australia incorporating Papua New Guinea, Australia and Tasmania. This paper provides initial results from crocodile feeding experiments aimed at characterising feeding damage inflicted on bones by the largest extant Australasian crocodile, *Crocodylus porosus*. Due to close similarity among *Crocodylus* species in dental and cranial morphology there are some general patterns in the way they modify bones. However, some differences arise when the taphonomic signatures are compared to those of the Nile crocodile (*Crocodylus niloticus*). We suggest that these differences are attributable to evolved differences in the feeding ecologies of the two species.

Somaweera, R. and Shine, R. (2011). The (non) impact of invasive cane toads on freshwater crocodiles at Lake Argyle in tropical Australia. Animal Consevation (doi:10.1111/j.1469-1795.2011.00500.x).

Abstract: The most substantial (and to date, unexplained) heterogeneity in the impact of toxic cane toads (Rhinella marina) on the native fauna of tropical Australia involves freshwater crocodiles (*Crocodylus johnstoni*); some populations have experienced catastrophic mortality whereas others have been unaffected. A trend for higher impact in more arid areas suggests that Western Australian (Kimberley region) crocodile populations may be at high risk. We monitored crocodile densities and body sizes, and the spread of cane toads, at a large water body (Lake Argyle) in the eastern Kimberley. Toads arrived on the lakeshore in early 2009, and spread to cover > 300 km of lakeshore, and colonize all of the larger islands within a 24-month period. Physical removal of >10,000 toads by a community group depressed toad abundances, but only briefly. Spool-tracking showed that toads moved extensively along the lakeshore (up to 90 m per night), often into floating vegetation in the lake. Crocodiles thus encountered toads (3–15% of crocodiles were <2 m from a toad when sighted), and we recorded 36 cases of toads being seized by crocodiles. Nonetheless, crocodile mortality was rare, and crocodile numbers did not decrease through time, nor differ between toad-infested versus toad-free areas of the lake. Although ingestion of a single adult toad may be fatal to a freshwater crocodile, and the Lake Argyle crocodiles encounter and consume these toxic anurans, the population-level impact of toad invasion has been trivial. Hence, the Lake Argyle crocodile population may not warrant immediate active management to reduce the impact of cane toads.

Somaweera, R., Webb, J.K. and Shine, R. (2011). Determinants of habitat selection by hatchling Australian freshwater crocodiles. PLoS ONE 6(12): e28533. doi:10.1371/journal.pone.0028533.

Abstract: Animals almost always use habitats non-randomly, but the costs and benefits of using specific habitat types remain unknown for many types of organisms. In a large lake in northwestern Australia (Lake Argyle), most hatchling (12-month old) freshwater crocodiles (*Crocodylus johnstoni*) are found in floating vegetation mats or grassy banks rather than the more widely available open banks. Mean body sizes of young crocodiles did not differ among the three habitat types. We tested four potential explanations for non-random habitat selection: proximity to nesting sites, thermal conditions, food availability, and exposure to predation. The three alternative habitat types did not differ in proximity to nesting sites, or in thermal conditions. Habitats with higher food availability harboured more hatchlings, and feeding rates (obtained by stomach-flushing of recently-captured crocodiles) were highest in such areas. Predation risk may also differ among habitats: we were twice as likely to capture a crocodile after seeing it in open-bank sites than in the other two habitat types. Thus, habitat selection of hatchling crocodiles in this system may be driven both by prey availability and by predation risk.

Khosa, P., Imbayarwo-Chikosi, V.E. and Hamandishe, V. (2011). Comparative analysis of hatching rates and clutch sizes of Nile crocodile (*Crocodylus niloticus*) eggs collected on- and off-farm in Zimbabwe. Tropical Animal Health and Production (doi: 10.1007/s11250-011-9985-z).

Abstract: The Nile crocodile (*Crocodylus niloticus*) is a large aquatic reptile predominant in the tropics in Africa and Zimbabwe in particular. Clutch sizes and hatching rates of Nile crocodile eggs collected from the wild and on-farm in Lowveld, Highveld and Kariba regions of Zimbabwe were evaluated. A total of 274 egg records for the period 2000 to 2008 from 39 farms were collected from the Crocodile Farmers Association of Zimbabwe. The effect of source of eggs was analysed using the non-parametric one way analysis of variance procedure of SAS Version 9.1.3. Wilcoxon signed rank test for independent samples was used to compare the mean hatching rates and clutch sizes for eggs collected from the different sources by region. The degree of association between clutch sizes and the hatching rates by source and region was determined using the Spearman's rank correlation test. Source of eggs had no effect ($P>0.05$) on hatching rates in all the regions but significantly influenced ($P<0.05$) clutch sizes in Lowveld and Kariba. In these regions, clutch sizes in the wild were significantly ($P<0.05$) higher than those on-farm. Correlation estimates between clutch size and hatching rates were weak and non-significant ($P>0.05$) for the different sources of eggs in all regions. Full utilization of the wild resource would reduce challenges relating to shortage of captive breeders and high cost of rearing breeders and hence increase productivity.

Riede, T., Tokuda, I.T. and Farmer, C.G. (2011). Subglottal pressure and fundamental frequency control in contact calls of juvenile *Alligator mississippiensis*. J. Exp. Biol. 214: 3082-3095.

Abstract: Vocalization is rare among non-avian reptiles, with the exception of the crocodilians, the sister taxon of birds. Crocodilians have a complex vocal repertoire. Their vocal and respiratory system is not well understood but appears to consist of a combination of features that are also found in the extremely vocal avian and mammalian taxa. Anatomical studies suggest that the alligator larynx is able to abduct and adduct the vocal folds, but not to elongate or shorten them, and is therefore lacking a key regulator of frequency, yet alligators can modulate fundamental frequency remarkably well. We investigated the morphological and physiological features of sound production in alligators. Vocal fold length scales isometrically across a wide range of alligator body sizes. The relationship between fundamental frequency and subglottal pressure is significant in some individuals at some isolated points, such as call onset and position of maximum fundamental frequency. The relationship is not consistent over large segments of the call. Fundamental frequency can change faster than expected by pressure changes alone, suggesting an active motor pattern controls frequency and is intrinsic to the larynx. We utilized a two-mass vocal fold model to test whether abduction and adduction could generate this motor pattern. The fine-tuned interplay between subglottal pressure

and glottal adduction can achieve frequency modulations much larger than those resulting from subglottal pressure variations alone and of similar magnitude, as observed in alligator calls. We conclude that the alligator larynx represents a sound source with only two control parameters (subglottal pressure and vocal fold adduction) in contrast to the mammalian larynx in which three parameters can be altered to modulate frequency (subglottal pressure, vocal fold adduction and length/tension).

De Silva, M.C., Thasun Amarasinghe, A.A., de Silva, A. and Suranjan Karunarathna, D.M.S. (2011). Mugger crocodile (*Crocodylus palustris* Lesson, 1831) preys on a radiated tortoise in Sri Lanka. Taprobanica 3(1): 38-41.

Abstract: The Mugger crocodile is the second largest crocodile in Sri Lanka. Recently we observed a Mugger attacking an unidentified radiated tortoise. The body morphology and colouration of this particular tortoise appeared different to the native Star tortoise widely distributed in the country. Thus, the possibility of an escaped or released exotic pet is discussed.

Eckalbar, W.L., Lasku, E., Infante, C.R., Elsey, R.M., Markov, G.J., Allen, A.N., Corneveaux, J.J., Losos, J.B., DeNardo, D.F., Huentelman, M.J., Wilson-Rawls, J., Rawls, A., Kusumi,K. (2011). Somitogenesis in the anole lizard and alligator reveals evolutionary convergence and divergence in the amniote segmentation clock. Developmental Biology (doi:10.1016/j.ydbio.2011.11.021).

Abstract: The axial skeleton is a defining feature of vertebrates and is patterned during somitogenesis. Cyclically expressed members of the notch and other signaling pathways, described as the 'segmentation clock', regulate the formation of somite boundaries. Comparisons among vertebrate model systems have revealed fundamental shifts in the regulation of expression among critical genes in the notch pathway. However, insights into the evolution of these expression differences have been limited by the lack of information from non-avian reptiles. We analyzed the segmentation clock of the first Lepidosaurian reptile sequenced, the green anole lizard, *Anolis carolinensis*, for comparison with avian and mammalian models. Using genomic sequence, RNA-Seq transcriptomic data, and in situ hybridization analysis of somite-stage embryos, we carried out comparative analyses of key genes and found that the anole segmentation clock displays features common to both amniote and anamniote vertebrates. Shared features with anamniotes, represented by *Xenopus laevis* and *Danio rerio*, include an absence of lunatic fringe (lfng) expression within the presomitic mesoderm (PSM), a hes6a gradient in the PSM not observed in the chicken or mouse, and EGF repeat structure of the divergent notch ligand, dll3. The anole and mouse share cycling expression of dll1 ligand in the PSM. To gain insight from an Archosaurian reptile, we analysed LFNG and DLL1 expressions in the American alligator. LFNG expression was absent in the alligator PSM, like the anole but unlike the chicken. In contrast, DLL1 expression does not cycle in the PSM of the alligator, similar to the chicken but unlike the anole. Thus, our analysis yields novel insights into features of the segmentation clock that are evolutionarily basal to amniotes versus those that are specific to mammals, Lepidosaurian reptiles, or Archosaurian reptiles.

Cherkiss, M.S., Romañach, S.S. and Mazzotti, F.J. (2011). The American crocodile in Biscayne Bay, Florida. Estuaries and Coasts 34(3): 529-535.

Abstract: Intensive crocodile monitoring programs conducted during the late 1970s and early 1980s in southern Florida resulted in an optimistic outlook for recovery of the protected species population. However, some areas with suitable crocodile habitat were not investigated, such as Biscayne Bay and the mainland shorelines of Barnes and Card Sounds. The objective of our study was to determine status and habitat use of crocodiles in the aforementioned areas. Spotlight and nesting surveys were conducted from September 1996 to December 2005. The results revealed annual increases in the number of crocodiles. Crocodiles preferred protected habitats such as canals and ponds. Fewer crocodiles were observed in higher salinity water. The distribution and abundance of crocodilians in estuaries is directly dependent on timing, amount, and location of freshwater delivery, providing an opportunity to integrate habitat enhancement with ongoing ecosystem restoration and management activities.

Wallace, K.M., Leslie, A.J. and Coulson, T. (2011). Living with predators: a focus on the issues of human-crocodile conflict within the lower Zambezi valley. Wildlife Research 38(8): 747-755.

Abstract: Human-wildlife conflict is a global problem and increasing worldwide as people and wildlife compete for limited resources. Conflict between people and crocodiles, especially in Africa, is recognised as a serious problem. The people of the Chiawa Game Management Area are heavily dependent on the Zambezi River for several resources from potable water and irrigating fields to a source of food (subsistence and small-scale commercial fishing). Aims: To assess the spatial and temporal scale of human-crocodile conflict (HCC) and identify associated factors, with a view to recommending mitigation measures. Methods: A questionnaire survey and Zambia Wildlife Authority data were utilised to estimate the scale of HCC. Key results: Between 2000 and 2009, there were 98 crocodile attacks on people, 62.2% were fatal. Most of the attacks occurred while canoe fishing (57.1%) and collecting water (29.6%). Crocodiles were disliked and seen as a 'problem' by the majority of the populace. Even though crocodiles are a charismatic mega-fauna species, being employed within the tourism industry had only a minor positive effect on people's attitudes. The area is an important location for crocodile egg and adult harvesting, although the local population gains no financial benefit. An increase in the number of boreholes in the villages was suggested by the local people as the primary mitigation measure, as well as the removal of crocodiles by various means. Conclusions:

Although people displayed an understanding of the risks of crocodile attack, very few actually employed mitigation techniques or utilised protective barriers when at the river. Increased water-access points (and their maintenance) in the villages would reduce people's dependency on the river. The negative attitude towards crocodiles is an issue that has to be addressed to allow successful implementation of long-term conservation strategies.

Saalfeld, D.T., Conway, W.C. and Calkins, G.E. (2011). Food habits of American alligators (*Alligator mississippiensis*) in East Texas. Southeastern Naturalist 10(4): 659-672.

Abstract: American Alligator (*Alligator mississippiensis*) food habit data are important when establishing management strategies, as diet can directly influence growth rates, body condition, behavior, and reproduction. Diets of American Alligators are hypothesized to vary among habitats as well as geographically; however, few diet studies have been conducted outside of Florida and Louisiana. To address this information gap, 62 diet samples were obtained from alligators ranging in size from 94.7 cm to 386.0 cm (total length) from June 2006-September 2008 in inland freshwater wetlands in East Texas. A total of 33 different prey items (comprising 670 individual prey items) and 1 parasite were identified. Irrespective of size class, sex, and study site, >85% of individual prey items were invertebrates. Nearly all diet samples contained some sort of organic by-catch and/or non-food items (i.e. woody debris, aquatic plants, seeds, rocks, fishing tackle, etc.). Although alligator diets were similar between sexes, non-breeding (<183.0 cm total length) alligators consumed more invertebrate prey items by biomass and percent occurrence than breeding-size alligators. In general, alligators forage opportunistically; therefore, most habitat-based, local, or geographic variability in food habits among populations are most likely influenced by food availability. As such, regional differences in food availability likely result in geographic variability in life-history characteristics such as growth rates and condition, important factors to consider when establishing management strategies.

Wang, J., Wu, X., Tian, D., Zhu, J., Wang, R. and Wang, C. (2011). Nest-site use by the Chinese alligator (*Alligator sinensis*) in the Gaojingmiao Breeding Farm, Anhui, China._Asian Herpetological Research 2(1). (doi: 10.3724/SP.J.1245.2011.00036).

Abstract: Nest-site and nesting material used by the Chinese alligator (*Alligator sinensis*) was studied at the Gaojingmiao Breeding Farm, Langxi County, Anhui, China from May to September 2009. In this study, artificial nesting materials were placed in 43 potential nesting sites before the nesting season, 11 of which were used. Additionally, 8 nests were built at natural sites without artificial nesting materials provided. Seven environmental variables were measured at each nest site: distance from water, height from water surface, sunlight duration, nearest bank slope, nest site slope, vegetation coverage and concealment. Statistical analyses indicated that concealment was significantly different between used and unused nest sites, with concealment being significantly correlated to the use of materials placed sites.In comparing the nests at artificial vs. natural sites,only the nearest bank slope differed significantly. Further, principal component analysis of natural nests indicated that the duration of nest exposure to sunlight and vegetation coverage were more influential than the other factors studied.

Yu, D., Peng, J., Hu, S., Gao, S., Fu, M., Hu, H. and Zou, J. (2011). Analysis of genetic variation and bottleneck in a captive population of Siamese crocodile using novel microsatellite loci. Conservation Genetics Resources 3(2): 217-220.

Abstract: The Siamese crocodile (*Crocodylus siamensis*), listed in CITES Appendix I, is considered one of the most critically endangered crocodilians in the world, and the reintroductions of it have been tried. Investigation of genetic variation for Siamese crocodile can help to conserve and improve this endangered species. Fourteen microsatellite loci were developed and twelve polymorphic loci were used to investigate the genetic variation and genetic bottleneck hypothesis on 48 captive individuals sampled in Guangdong Provincial Wildlife Rescue Center in Guangzhou. The allele number of polymorphic markers ranged from 2 to 10 per locus, with the average of 4.357. Observed heterozygosity ranged from 0.063 to 0.649 and expected values ranged from 0.259 to 0.844. The Shannon information index and Polymorphic Information Content showed that most of the loci were highly informative with an overall mean of 0.941 and 0.440, respectively. The bottleneck analysis provided evidence of a significant genetic signature of population decline.

Ferreira, S.M. and Pienaar, D. (2011). Degradation of the crocodile population in the Olifants River Gorge of Kruger National Park, South Africa. Aquatic Conservation: Marine and Freshwater Ecosystems 21(2): 155-164.

Abstract: Top predators such as crocodiles often reflect ecosystem degradation. The recent spate of close to 200 Nile crocodile deaths may reflect the ecosystem state of the Olifants-Letaba River system in the Kruger National Park. This paper investigates whether the crocodile deaths were indeed the consequence of a rare and perhaps acute event given the variability in annual population growth rates of crocodilians. Spotlight- and helicopter-based surveys designed to correct for availability and detectability bias were used to estimate population sizes of crocodiles from 2008 to 2010 in and around the Olifants River Gorge, the focal area of crocodile deaths. Correction factors derived from individually observed crocodiles for both spotlight- and helicopter-based counts were lower than those typically used for Nile crocodiles as well as other crocodile species. Even so, corrected spotlight- and helicopter-based estimates were comparable and the number of crocodiles in the focal study area declined significantly from 780 (95% CI: 637-1222) to between 460 (spotlight estimate, 95% CI 375-665) and

505 (aerial estimate, 95% CI: 559-1746) during the period of crocodile deaths. The average annual decline of 35% was at the lower end of the distribution of annual population growth rates across the rivers of Kruger National Park. The crocodile deaths reflect a possible rare event that suggests a degraded crocodile population, possibly the consequences of broad-scale cascades of environmental deterioration of the Olifants-Letaba River system. Even so, the potential risk of local demise of the population in the focal study area in the short term may be diminished through evolutionary, demographic and spatial resilience inherent within crocodiles that can accommodate the as yet unknown disease dynamics of pansteatitis.

Bermudez, D.S., Skotko, J.P., Ohta, Y., Boggs, A.S.P., Iguchi, T. and Guillette Jr., L.J. (2011). Sex steroid and thyroid hormone receptor expressions in the thyroid of the American alligator (*Alligator mississippiensis*) during different life stages. Journal of Morphology 272(6): 698-703.

Abstract: The expression of estrogen receptors, ESR1 (ERα) and ESR2 (ERβ), and androgen receptors (AR) in the thyroid gland has been reported in few vertebrate species other than a few mammals. This study reports the presence of sex steroid hormone receptors and thyroid receptors (ERα, ERβ, AR, TRα, and TRβ) in the thyroid gland of the American alligator at several life stages. It provides a semiquantification and distribution of ERα in the thyroid follicle cells using an immunohistochemical approach as well as reports quantitative differences in mRNA expression of ERα, ERβ, TRα, TRβ, and AR in the same tissue using quantitative real time-PCR (Q-PCR) with primers designed specifically for alligators. The thyroid tissue of the American alligator expresses ERα, ERβ, and AR at all of the life stages examined here although no statistically significant differences were observed between male and female in thyroid mRNA expression for any of the genes analyzed. No sexual dimorphism was observed in ERα immunostaining. No statistical analysis across life stages were performed due to confounding factor of season.

Boggs, A.S.P., Hamlin, H.J., Russell H. Lowers and Guillette Jr, L.J. (2011). Seasonal variation in plasma thyroid hormone concentrations in coastal versus inland populations of juvenile American alligators (*Alligator mississippiensis*): Influence of plasma iodide concentrations. General and Comparative Endocrinology 174(3): 362-369.

Abstract: Thyroid hormones, essential for normal growth and health, are associated with changes in temperature, photoperiod, and reproduction. Iodide, a necessary element for thyroid hormone production, varies in diet, and is more abundant in estuarine environments, which could alter thyroid hormone variation. However, associations between thyroid hormone concentrations in animals from marine versus freshwater environments, which could become more pertinent with rising sea levels associated with global climate change, are not well studied. To determine the importance of dietary iodide in seasonal variation of plasma thyroid hormone concentrations, we analyzed seasonal variation of plasma thyroxine (T4) and triiodothyronine (T3) concentrations in juvenile alligators from an estuarine habitat (Merritt Island National Wildlife Refuge; MI) and a freshwater habitat (Lake Woodruff National Wildlife Refuge; LW) and compared these results to plasma inorganic iodide (PII) concentrations. Alligators from MI did not display seasonal variation in plasma T4, but exhibited a seasonal pattern in plasma T3 concentrations similar to alligators from LW. Plasma thyroid hormone concentrations were consistently higher at MI than at LW. PII concentrations were correlated with plasma T4 and T3 concentrations in juvenile alligators from LW but not MI. The data on plasma T4 and T3 concentrations suggest altered iodide metabolism in estuarine alligators. Differences in thyroid hormone concentrations between the populations could be due to differences in dietary iodide, which need to be further evaluated.

Martins, R.M.S., Beckmann, F., Castanhinha, R., Mateus, O. and Pranzas, P.K. (2011). Dinosaur and Crocodile Fossils from the Mesozoic of Portugal: Neutron Tomography and Synchrotron-Radiation Based Micro-Computed Tomography. MRS Proceedings 1319: mrsf10-1319-ww02-03 (14 pp). (doi: 10.1557/opl.2011.794 (About DOI).

Abstract: Portugal is ranked within the 10 countries with the most dinosaur taxa and the Lourinhã Formation is known by the Late Jurassic findings of dinosaurs and other fossils. In many cases, studies of the external morphological characteristics of the fossils are not sufficient to extract all the information for a paleontological study and, thus, observations of internal structures, using non-destructive techniques, are required. The fossils studied in the present work belong to the Museum of Lourinhã. The access to the Geesthacht Neutron Facility in Germany allowed us to characterize a jaw of the dinosaur *Baryonyx walkeri* specimen and the jaw of a crocodile (possibly a Tomistomidae) by Neutron Tomography. The study allowed us to detect the presence of teeth inside the jaws and it provides valuable information about the development of its dental characteristics. Synchrotron radiation based micro-computed tomography studies on tiny samples have been performed at the beamline HARWI II operated by the Helmholtz-Zentrum Geesthacht at the storage ring DORIS III at the Deutsches Elektronen-Synchrotron DESY in Hamburg, Germany. The first data recorded for eggshells collected in the Lourinhã Formation is shown. It allowed us to visualize the morphology of the pores and their connectivity in the eggshells, providing information that is either exceedingly difficult or impossible to obtain by traditional methods based on section cutting.

Botha, H.,van Hoven, W. and Guillette Jr, L.J. (2011). The decline of the Nile crocodile population in Loskop Dam, Olifants River, South Africa. Water SA 37(1): 103-108.

Abstract: The apparent decline in the number of Nile crocodiles present in the Loskop Dam prompted a study to determine the number, size and distribution of Nile crocodiles now present

in the reservoir. The number of crocodiles in the Loskop Dam was surveyed using aerial counts and spotlight counts. Surveys revealed the presence of a very low total number of crocodiles and also a poor distribution of crocodiles in the different size classes over almost 30 years since 1981. Eight surveys carried out between 2001 and 2010 revealed that the distribution pattern of crocodiles in the Loskop Dam did not vary between winter and summer. These distribution patterns indicate that crocodiles occur most frequently in the eastern and western inlets and not in the main basin of the dam. Thirteen crocodiles were re-introduced into the dam during March 2007; however the August 2009 spotlight survey results indicated that none of these animals had survived.

Davis, A.K., Horan III, R.V., Grosse, A.M., Harris, B.B., Metts, B.S., Scott, D.E. and Tuberville, T.D. (2011). Gender differences in haemogregarine infections in American alligators (*Alligator mississippiensis*) at Savannah River, South Carolina, USA. Journal of Wildlife Diseases 47(4): 1047-1049.

Abstract: We report a host gender bias in haemogregarine infection characteristics in the American alligator (*Alligator mississippiensis*) at the Savannah River Site, South Carolina, USA. Prevalence and severity in female alligators was higher than it was in males. The reason for this pattern is not clear.

Troy Francis Davis (2011). Development of a Total Nutrient Treatment System for Alligator and Dairy Parlor Wastewater Using Hydrated Lime and Organic Bacterial Growth Media. MSc Thesis, Louisiana State University, USA.

Abstract: Over application of phosphorus and the loss of ammonia-nitrogen to runoff and volatilization have resulted in the buildup of phosphorus in agricultural top soils around the world, and especially in the United States. Over the past few decades, raising livestock has trended towards the development of the Confined Animal Feeding Operations (CAFO's) which produce large volumes of wastes that need to be treated before being land applied. Nutrient treatment systems have typically focused on one nutrient singularly: either nitrogen or phosphorus. In order to develop a total nutrient system a phosphorus and nitrogen system had to be developed and evaluated before combining them to represent a complete system. A pilot phosphorus treatment system consisting of hydrated lime precipitation treatment was evaluated on both an alligator ranch and a dairy parlor research station. An 88% reduction of total phosphorus in the alligator raising pen wastewater was achieved and a 99% reduction of total phosphorus was achieved in the dairy parlor wastewater. The system added $0.00197/gal-year when treating the alligator wastewater and added $0.00033 /gal-year when treating the dairy parlor wastewater. A pilot nitrogen treatment system consisting of a nitrification reactor utilizing rice hulls as the bacterial growth media was developed at the lab scale before eventually being implemented in a field scale nutrient treatment system. The lab scale results showed 50% ammonia oxidation occurring at 30-hrs, 48-hrs, and 48-hrs after commencement of the three experiments. They were encouraging enough to continue on to total nutrient treatment system development.A total nutrient treatment system was designed to both remove phosphorus and to keep usable nitrogen in the wastewater. A 99% reduction in total phosphorus was achieved in a matter of hours and 50% oxidation of the total ammonia was achieved in 5-days and 4-days of treatment in each field-trial. The total treatment system had the potential to save $2,500 annually in nitrogen kept in solution and not lost to volatilization and added $1.78 /cow-year in phosphorus recovery through the hydrated lime treatment.

Moore, B.C., Roark, A.M., Kohno, S., Hamlin, H.J. and Guillette Jr, L.J. (2011). Gene-environment interactions: the potential role of contaminants in somatic growth and the development of the reproductive system of the American alligator. Molecular and Cellular Endocrinology (doi:10.1016/j.mce.2011.10.020).

Abstract: Developing organisms interpret and integrate environmental signals to produce adaptive phenotypes that are prospectively suited for probable demands in later life. This plasticity can be disrupted when embryos are impacted by exogenous contaminants, such as environmental pollutants, producing potentially deleterious and long-lasting mismatches between phenotype and the future environment. We investigated the ability for in ovo environmental contaminant exposure to alter the growth trajectory and ovarian function of alligators at five months after hatching. Alligators collected as eggs from polluted Lake Apopka, FL, hatched with smaller body masses but grew faster during the first five months after hatching, as compared to reference-site alligators. Further, ovaries from Lake Apopka alligators displayed lower basal expression levels of inhibin beta A mRNA as well as decreased responsiveness of aromatase and follistatin mRNA expression levels to treatment with follicle stimulating hormone. We posit that these differences predispose these animals to increased risks of disease and reproductive dysfunction at adulthood.

Bayani, A.S., Trivedi, J.N. and Suresh, B. (2011). Nesting behaviour of *Crocodylus palustris* (Lesson) and probable survival benefits due to the varied nest structures. Electronic Journal of Environmental Sciences 4: 85-90.

Abstract: River Vishwamitri, although passing through densely populated areas of Vadodara city, supports a healthy breeding population of *Crocodylus palustris*. An extensive study for a period of one year resulted in perceiving four different kinds of nests having quite different and unique features associated with their typical and discrete usage. Based upon the nest architecture, the nests could be defined as Funnel Nest, Simple Tunnel Nest, Chamber Nest and Tunnel Nest with Doorsill. All the nest types served different purposes likewise, the Funnel Nests were mainly used by the adult crocodiles for resting whereas the Chamber Nests were used for egg laying. The Tunnel Nest with a Doorsill

perhaps served a dual purpose of providing a hiding place for the hatchlings in the initial days and also preventing the entry of water into the nest hole. Nesting behaviour was studied extensively and a few physical parameters like the ambient temperature and humidity were recorded on a periodic basis and were correlated with the nest architecture. Population trend revealed that the choice of nest site and the type of nest has crucial role in the survival of the species.

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

Abstract: Koshi Tappu Wildlife Reserve is an area of 175km2 on the alluvial floodplains of the Koshi River in eastern Nepal. Surveys of crocodiles in the Koshi River and its surrounding areas in the reserve were conducted in winter and spring 2008 using direct observation and questionnaires besides literature reviews. Observations were done during the day using binoculars and photo shoots and sites were visited by boat, bicycle and also on foot. Although both *Gavialis gangeticus* and *Crocodylus palustris* were previously found in the reserve, only *C. palustris* was found in this study. The numbers of *C. palustris* were higher in the winter season-early January (21) than in the spring-mid March (5). The destruction and degradation of crocodiles in the reserve has been caused by various human activities such as wood collection, cattle grazing, fishing, as well as by some natural processes. The success of conservation programs depends upon awareness creation and the development of a positive attitude in the local people towards the species. During this study, most of the respondents from the local community as well as the Reserve staff were positive towards the conservation of *C. palustris*. This is important as it has its own role in the ecosystem. Continuous release and trans-boundary conservation efforts should be initiated for the protection of *G. gangeticus*.

Escobedo-Galván, A.H., González-Salazar, C., López-Alcaide, S., Arroyo-Peña, V.B. and Martínez-Meyer, E. (2011). Will all species with temperature-dependent sex determination respond the same way to climate change? A reply to Kallimanis (2010). Oikos 120(5): 795-799.

Abstract: Recently, Kallimanis (2010) published a paper proposing a mechanism by which temperature-dependent sex determination (TSD) may play a key role at facilitating species with this strategy to track their climatic niches across space under climate change. Kallimanis hypothesized that TSD species currently inhabiting stable climatic conditions show reduced population growth rates at the edges of their distributional ranges; under warming conditions, these populations will experience faster growth rates and thus are able to colonize new suitable sites. These ideas are based on the assumption that populations of TSD species have balanced sex ratios at the core of their geographic ranges and biased proportions at the edges. However, Kallimanis' model overlooks complex processes that may produce a more broadly and less predictable aftermath of climate change on TSD species, so we discuss some of his postulates and underlying assumptions. Kallimanis' model is based only on one of three known TSD strategies in reptiles, thus it lacks generality; and it does not consider the phenological, behavioral, and physiological strategies that TSD species exhibit across their geographic ranges to buffer the potential impacts of climatic variation over the whole reproductive process. We conclude that simple models such as the one proposed by Kallimanis are not broadly applicable; hence, forecasts of TSD species' responses to climate change will need to be more specific to groups with similar ecologies and modes of TSD.

Muniz, F.L., Da Silveira, R., Campos, Z., Magnusson, W.E., Hrbek, T., Farias, I.P. (2011). Multiple paternity in the Black Caiman (*Melanosuchus niger*) population in the Anavilhanas National Park, Brazilian Amazonia. Amphibia-Reptilia 32(3): 428-434.

Abstract: The formation of dominance hierarchies in which the female mates with a large dominant male is common among crocodilians. However, there is the possibility of polyandry, in which females mate with multiple partners during a single breeding season and generate offspring with multiple paternity. In the present study, eight pairs of heterologous primers developed for *Alligator mississippiensis* and *Caiman latirostris* were used to determine whether multiple paternity exists in the Black Caiman, *Melanosuchus niger*. For such, we analyzed 34 Black Caiman offspring from the Anavilhanas Archipelago in the Negro River (state of Amazonas, Brazil). The specimens came from six groups, each containing five or six hatchlings. Paternity exclusion and genetic identity indices were calculated to test the robustness of the microsatellite loci. Simple allele counts and maximum likelihood estimation of family clusters were used to determine the likelihood of occurrence of multiple paternity. Among the eight loci tested, five were effective at determining paternity, with paternity exclusion values close to 1.0 (QC= 0.92) and genetic identity values close to zero (IC<0.01). Using the simple allele count, six cases of multiple paternity were detected and confirmed in three hatchling groups by four different microsatellite loci. However, maximum likelihood analysis indicated multiple paternity in all the groups analyzed, with five family clusters identified in one hatchling group alone. Considering that this species is listed according to IUCN as Lower Risk/ Conservation Dependent, our results have direct conservation implications. Multiple paternity increases effective population size by maintaining genetic variation, and thus could be an important mechanism to maintain genetic diversity in isolated local populations.

Submitted Articles

PRELIMINARY RESULTS ON NESTING ECOLOGY OF *CROCODYLUS ACUTUS* ON COZUMEL ISLAND, MEXICO. The American crocodile (*Crocodylus acutus*) inhabits the coastal areas and islands of Quintana Roo in the Yucatan Peninsula, Mexico (Cedeño-Vázquez *et al*. 2006; Charruau *et al*. 2005, 2010). From the early 1930s to the early

1960s there was heavy exploitation of *C. acutus* in Quintana Roo for skin trade (Casas-Andreu and Guzmán-Arroyo 1970). In 1939 a decree published in the Diario Oficial de la Federación (D.O.F.) established a 5-year ban on crocodile capture in states of the Yucatan Peninsula (Campeche, Yucatan and Quintana Roo) (D.O.F. 1939). However, crocodile hunting occurred legally until 1970 when a national and permanent ban of crocodile exploitation was established in Mexico (Casas-Andreu 1995).

Illegal exploitation of crocodiles occurred until the early 1980s in Quintana Roo (Cedeño-Vázquez *et al*. 2006). Cedeño-Vázquez *et al*. (2006) and Platt and Thorbjarnarson (2000a) did not observe any evidence of poaching in the region, but reported incidental drowning of crocodiles in fishermen nets and occasional killing of crocodiles near human settlements where they are perceived as a threat. *Crocodylus acutus* is currently protected by Mexican law as a "species subjected to special protection" (NOM-059-ECOL-2010, D.O.F. 2010) but the past crocodile exploitation led to the depletion of *C. acutus* populations in Quintana Roo (Cedeño-Vázquez *et al*. 2006).

Currently, these populations show a slow recovery, with small fragmented populations, high level of hybridization with the sympatric Morelet's crocodile (*C. moreletii*) and poor recruitment (Cedeño-Vázquez *et al*. 2006, Machkour M'rabet *et al*. 2009). However, recent studies show that island populations of *C. acutus* in the Mexican Caribbean are relatively well conserved with genetically-pure individuals of all size classes, albeit with male-biased sex-ratios (Charruau *et al*. 2005; Charruau 2010, 2011; González-Cortés 2007; Machkour M'rabet *et al*. 2009). In this context, island populations of *C. acutus* appear as possible good source of individuals for the recovery of the species in continental areas. Thus, in past years we start a project to study and assess the reproduction and nesting ecology of these populations, beginning with the population of Banco Chinchorro Atoll (Charruau 2010, 2011; Charruau *et al*. 2010). In July 2011 we went to Cozumel Island to collect the first data on the nesting ecology of *C. acutus* in the south of the island and results of this first survey are presented and discussed here.

From 4-9 July 2011 we searched for nesting areas in the Ecological Reserve Punta Sur [see description in Charruau (2010) and González Cortés (2007)], located in the southern tip of the island (Fig. 1). In each potential nesting area we searched for *C. acutus* nests. When a nest was found we recorded its location with Global Positioning System (GPS). We also recorded the vegetation type and material of the nest, and measured the distance to the nearest body of water (± 1 m) when possible. Intact nests were carefully excavated to determine clutch size, egg chamber dimensions, and egg characteristics and dimensions. Prior to removal from nests, eggs were marked with pencil on the uppermost surface in order to maintain its original orientation. Eggs were measured (length and width) with calipers (± 0.1 mm). We determined the viability of eggs and replaced them in the nest in their original position. When nests hatched we took the same measures as for intact nests when possible and searched for evidence of female assistance during the emergence of hatchlings. Additional to our survey we add the information of a nest found in 2009 (Charruau and Hénaut 2012) and information on location on several nests observed from 2001 to 2010 in the park by H. González Cortés who studied *C. acutus* population in Punta Sur since 2001 (González-Cortés 2007).

Figure 2. Map of the study area with locations of *C. acutus* nests and nesting areas (NA).

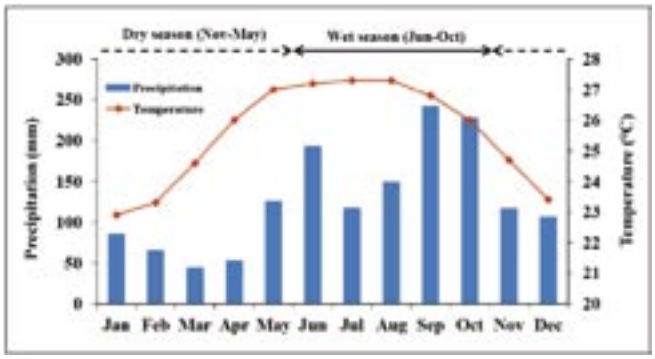

Figure 1. Climatic data for Cozumel.

During the survey we found a total of 8 *C. acutus* nests in Punta Sur, 7 from 2011 and one from 2010. We also obtained the location of another 8 nests observed between 2001 and 2010 by H. González Cortés and of one nest found in 2009 in the park (Charruau and Hénaut 2012). The seven nests of 2011 were hatched indicating that hatching occurs in June or earlier. Furthermore, the nest found in 2009 hatched on 29 June (Charruau and Hénaut 2012). Assuming that the last week of June is the last week of hatching and that incubation length is around 85 days (Charruau *et al*. 2010; Thorbjarnarson 1989), last oviposition may occur in early April, suggesting that March may be the month of the peak nesting activity. Moreover, mating has been observed in the park in middle March (H. González Cortés, pers. obs.). This nesting period would be similar to the nesting period of C. acutus in Belize which deposit their clutch from late March to early May with hatching from late June to mid-July (Platt and Thorbjarnarson 2000b). As in the majority of cases in *C. acutus*, the oviposition in Cozumel seems to occur during the last half of the dry season with hatching at the beginning

of the rainy season (Fig. 2), that would provide the better conditions for hatchlings survival (Cott 1961; Thorbjarnarson 1989; Platt and Thorbjarnarson 2000b).

The 17 nests were distributed in four nesting areas (Fig. 2). Most of them (n= 14; 82.4%) were in the elevated sandy dune located between the sea and lagoons and covered by dune vegetation. Other 3 nests (17.6%) were located between the dune and Columbia Lagoon in coastal bush. These three nests were mound nests (Fig. 3) with a mean height of 45.0 ± 5.0 cm (range: 40-50 cm). These nests were considered mound nest because the clutch was deposited above the soil level in a monticule of sand piled up by the female (Fig. 3). The other nests observed in 2009 (n= 1) and 2011 (n= 5) were hole nests (Fig. 4). *Crocodylus acutus* is primarily a hole nester but the species has been observed to make mound nests in the Yucatan Peninsula and other regions throughout its range (Campbell 1972; Charruau *et al*. 2010; Platt and Thorbjarnarson 2000b). Construction of mound nests may reduce the probability of nest flooding in low elevated areas (Thorbjarnarson 1989). The three mound nests observed were located at a short distance of the lagoon shore in areas that can be flooded. From information collected so far, crocodiles in Punta Sur seem to reuse the same nesting areas from year to year; something which has been observed in other studies for this species (Charruau *et al*. 2010; Platt and Thorbjarnarson 2000b). Mean distance from nests to the nearest body of water was 24.5 ± 19.7 m (range: 9-50 m; n= 4). Material of the nest consisted in sand (n= 6) or sand with a little leaf litter (n= 3) that is typical for *C. acutus* (Charruau *et al*. 2010; Platt and Thorbjarnarson 2000b; Thorbjarnarson 1989).

Concerning clutches characteristics, we collected information on clutch size, egg dimensions and viability from two nests. One was the nest of 2010 found during our survey; this nest failed and we suppose that is certainly due to heavy rains at the beginning of the incubation period in 2010. The nest was not in an area that can be flooded. However, heavy rainfall can cause a rapid decrease of several degrees in temperature of *C. acutus* nests that can kill embryos (Charruau 2011). Most of eggs were rotten and show early embryonic death; only two eggs presented completely formed embryos which died in the nest trying to emerge from it. The other nest was found in 2009 during a study of nesting etology and was successful (Charruau and Hénaut 2012). For the nest of 2010, the depth from soil surface to the uppermost egg was 20 cm and depth to the bottom of the clutch was 42 cm, dimensions of eggs chamber were 30 x 34 cm. Means of clutch and egg characteristics are presented in Table 1. Mean clutch size and mean dimensions of eggs seem to be higher than those reported in the region (Table 1). The egg ratio (length to width) appears similar of that found in Banco Chinchorro and Belize (Table 1). Clutch fertility appears to be higher than in Belize and lower than in Banco Chinchorro (Table 1). However, data are only from two nests and more information must be collected during next years to obtain accurate results.

Figure 3. Mound (left) and hole (right) nests of *C. acutus* in Punta Sur.

Studies on maternal care in *C. acutus* in Banco Chinchorro and Cozumel show that females visit their nest during incubation, help the hatchlings to emerge from the nests and transport them to the water (Charruau and Hénaut, 2012). This coincides with our observations as we identified that 77.8% of the nests received assistance from an adult crocodile during hatching in Punta Sur. Moreover, in one occasion we observed an adult crocodile on the shore near a hatched nest (9 m) that fled into the water when approached. We assumed that it was the female corresponding to this nest.

This preliminary survey permitted to obtain first information on nesting ecology of *C. acutus* in Cozumel Island. Next year we will inspect nesting areas in March to examine fresh nests and to collect more data on nesting period, nest and egg characteristics, nest microclimate and nesting etology. This information will be very valuable for the conservation of *C. acutus* in Quintana Roo.

Table 1. Mean characteristics of *C. acutus* clutches and eggs at Cozumel Island, Banco Chinchorro (Charruau *et al*. 2010) and Belize (Platt and Thorbjarnarson 2000b). *calculated from mean egg width and mean egg length. SD= standard deviation.

Parameters	Cozumel				Banco Chinchorro	Belize
	N	Mean	SD	Range	Mean ± SD	Mean ± SD
Clutch size	2	25.5	2.1	24-27	16.2 ± 4.6	22.3 ± 6.0
Egg width (mm)	47	45.8	0.6	44.4-47.0	43.3 ± 1.6	44.1 ± 1.6
Egg length (mm)	46	72.4	2.5	65.3-77.1	69.3 ± 3.4	70.5 ± 4.3
Egg ratio (L/W)	46	1.58	0.05	1.44-1.71	1.57 ± 0.09	1.60 *
Clutch fertility (%)	2	69.3	14.1	59.3-79.2	86.2 ± 9.0	53.5

Acknowledgements

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VHF-Tracking of *Tomistoma schlegelii* in Tanjung Puting National Park, Central Kalimantan, Indonesia: a short overview

[Adapted from report to CSG Tomistoma Task Force]

The Tomistoma (*Tomistoma schlegelii*) is a large freshwater crocodile predominantly inhabiting peat swamp forest in Southeast Asia. It is known to be one of the least investigated crocodilian species, with limited available survey data (Bezuijen *et al*. 2010). The current distribution of *T. schlegelii* encompasses Indonesia (Kalimantan, eastern Sumatra, western Java) and Malaysia (Peninsular Malaysia, Sarawak). Historically *T. schlegelii* reportedly occurred in Thailand, but it is now considered to be extinct there (Stuebing *et al*. 2006; Bezuijen *et al*. 2010).

The available ecological data for the species are mainly derived from a low number of short-term status assessments (Auliya 2000, 2002a,b, 2003; Auliya *et al*. 2006; Bezuijen *et al*. 1995, 1997, 1998, 2001b, 2002a,b; Bezuijen 2004; Cox and Gombek 1985; Frazier 1994; Frazier and Maturbongs 1990; Muin and Ramono 1994; Ramono 1994; Ross *et al*. 1998; Sebastian 1993a,b, 1994; Simpson *et al*. 1998; Simpson 2004). Until now there have been no long-term studies investigating the species.

Within the scope of the PhD study of the author, an autecological study split into two intervals (May 2008-August 2008, August 2009-October 2009) was implemented in Tanjung Puting National Park (TPNP; Central Kalimantan, Indonesia). This PhD study aimed at deeper insights into the ecology of *T. schlegelii* and will be finalized in the near future at the Zoologisches Forschungsmuseum Alexander Koenig (Bonn, Germany).

Even though *T. schlegelii* exhibits highly secretive habits, animals can be spotted in TPNP in high densities (Auliya 2006; Simpson 2004). Causes of this "deviant" behaviour are likely to be the regular boat traffic resulting from high visitation of tourists to the park. Animals show high tolerance to human activities, hence optimum research conditions exist.

Objectives of this study were the evaluation of population size, population structure, habitat requirements and preferences, reproductive biology and key threats to the species. Preliminary results of the first study period were presented recently (Bonke 2009). A priority objective of the study was the assessment of Tomistoma movement patterns. Initial results from 2008 suggested high side fidelity of *T.schlegelii,* but identification of individuals was only possible in a few cases (Bonke 2009). To gain a better understanding of movement patterns, radio-telemetry was employed to track three *T. schlegelii* during the second phase of the study in 2009. Here, a short overview of the telemetry results is presented.

The three Tomistoma (total lengths of 118 cm, 134 cm and 178 cm and bodyweights of 3.799 kg, 5.389 kg and 12.792 kg respectively) were captured using a self-made snare-pole, in the Sekonyer-Kanan River. The first animal captured had been previously captured and marked in 2008.

To prevent any restriction in movement of the animals, housing dimensions of transmitters were chosen as small as possible. The ear-tag VHF-transmitters chosen (TX-124E) were manufactured by TELENAX-Wildlife Telemetry), and were attached to the tail scutes (see Fig. 1). Two of the three animals were released at their capture site, and one was released approximately 1 km downstream of its original capture, in a small branch of the Sekonyer Kanan River.

Figure 1. Ear-tag transmitter attached to tail scutes of *T. schlegelii*.

All attempts were made to ascertain locations of animals once per day using a foldable Yagi-antenna and receiver unit (RX-TLNX). However, daily tracking was not always possible due limited availability and functioning of vessels. A total of 108 fixes were recorded between 3 September and 28 October (56 days) (see Table 1 for related data). A graphic representation of individual tracking points (fixes) are on Figure 2.

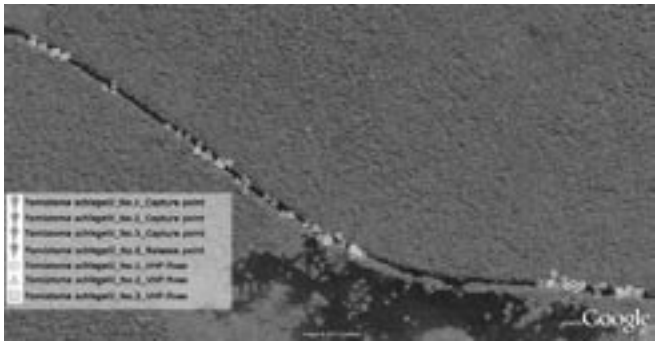

Figure 2. Capture/release sites and location fixes for three *T. schlegelii* tracked in Tanjung Puting National Park (see Table 1).

Notwithstanding the relatively short period over which tracking occurred, the results confirm high site fidelity of *T. schlegelii* previously indicated from survey results (in 2008). The individual released away from its original capture site returned to it (Fig. 2).

Table 1. Data relating to *Tomistoma shhlegelii* radio-tracked in Tanjung Puting National Park in 2009.

No.	Capture Date	Release Date	Tracking Period	TL (cm)	BWt (kg)	No. of Fixes
1	31 Aug	1 Sep	3 Sep-28 Oct	118	3.8	41
2	3 Sep	5 Sep	6 Sep-28 Oct	178	12.8	38
3	16 Sep	17 Sep	19 Sep-28 Oct	134	5.4	29

None of the transmitters were lost or showed any indication of electronic failure, and the attachment method was considered to be efficient. Strauss *et al*. (2008) reported high failure rates for VHF-transmitter attachment to the tails of *C. niloticus* and considered this area to be inappropriate for attachment. However, this type of attachment has been successful and long-lasting for *Gavialis gangenticus* (Madras Crocodile Bank Trust and Gharial Conservation Alliance 2010). Certainly, various conditions (eg habitat structure, intraspecific behaviour) may affect the efficacy of transmitter attachment methods. Further investigations using this attachment method over a longer time-frame are desirable. A more detailed analysis of these results will be provided in subsequent publications.

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Morelet's crocodile (*Crocodylus moreletii*). Photograph: Paul Bodnar.

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