

**CROCODILE  
SPECIALIST  
GROUP  
NEWSLETTER**

VOLUME 29 No. 4 • OCTOBER 2010 - DECEMBER 2010



# CROCODILE

# SPECIALIST

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IUCN - Species Survival Commission

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**CHAIRMAN:**

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

**EDITORIAL AND EXECUTIVE OFFICE:**

PO Box 530, Karama, NT 0813, Australia

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**COVER PHOTOGRAPH:** Spectacled caiman (*Caiman crocodilus*). Photograph: Jerónimo Domínguez-Laso.

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## Editorial

It was fascinating to get into communication with Simon Pooley, son of Tony Pooley (1938-2004), one of the CSG's pioneers. Simon is an environmental historian who is proposing to research and document the "History of the IUCN SSC Crocodile Specialist Group (CSG)". If grant applications are successful, the work will be undertaken through the Imperial College (UK), and of course, the CSG has been highly supportive.

In a Jamaican newspaper were reports on the killing and consumption of crocodiles by local people [see CSGN 29(3): 14]. It raised concerns about the conservation and management of American crocodiles in Jamaica, and I wrote to the CEO of the National Environment and Planning Agency (NEPA), seeking clarification. Bryon Wilson, a long-time crocodile conservationist and CSG supporter, subsequently met with NEPA officials, and they have agreed to update their draft crocodile management plan and to request the CSG to undertake a review of that plan.

As CSG Chair, I nominated Dr. Holly Dublin (previous SSC Chair) for the UNEP-"The 2011 Champions of the Earth" award. The winner of this award is selected from individuals who have made a significant contribution globally, regionally and beyond, to the protection and sustainable management of the environment and natural resources. Holly has spent the past three decades as an active practitioner - linking the inherent values of biodiversity and ecosystem services to human livelihoods and well-being. She has been an active player in local, national and international policy forums, including CITES, the Convention on Biological Diversity (CBD), the Convention on Migratory Species (CMS) and the UN Framework Convention on Climate Change (UNFCCC). She may not win (it is highly competitive), but deserves to be considered.

I recently wrote to Mr. Jairam Ramesh, Indian Minister of Environment and Forests, congratulating him on the formation of a National Tri-State Chambal Sanctuary Management and Coordination Committee to invigorate efforts to conserve Gharial (*Gavialis gangeticus*) (see page 11). Mr. Ramesh visited the Madras Crocodile Bank on 27 December, spending an hour with Rom Whitaker and MCB staff, who have encouraged this initiative.

CSG-Tomistoma Task Force funding of €1025 was provided to Agata Staniewicz for her to assist Yayasan Ulin, East Kalimantan, with survey work being undertaken in Lake Mesangat on *Crocodylus siamensis* and *Tomistoma schlegelii*. The preliminary results of the survey confirm a significant presence of both species in Lake Mesangat, which is under threat from oil palm plantations. We believe that Lake Mesangat merits declaration as a wetland of international importance by RAMSAR, which will only be possible if the Governments of East Kalimantan and Indonesia agree.

Egyptian authorities, who obtained an Appendix-II listing of Nile crocodiles with a zero quota at CITES CoP15, have sought advice on what would be required to establish a quota at CoP16 (2013). It will clearly require another proposal, and a management program that satisfies Article IV of the CITES Convention, particularly the non-detriment provisions. A workshop to develop such a management program is planned for early 2011. Recent newspaper reports of illegal hunting of crocodiles in Lake Aswan are being investigated by the, Egyptian Environmental Affairs Agency.

The CSG Latin America and Caribbean Region Steering Committee provided comments to Mexico on a "Procedures Manual - Monitoring of Morelet's Crocodile". The draft was developed after the Tri-National Mexico-Belize-Guatemala Workshop held in 2010, and will be used as an official field guide for training and fieldwork for the Monitoring Program.

The Thai Department of Fisheries and Mahidol University (Bangkok) will host an International Crocodile Specialist Group Regional Species meeting at Mahidol University on 4-6 April 2011 (see page 4). The main purpose of the meeting is to review the conservation, management, farming, regulation, enforcement and trade in *C. siamensis* at national and international levels, and to try and formulate priorities for enhancing conservation and ensuring that trade is legal, sustainable and verifiable. The meeting will be followed by a field trip on 7 April 2011 to Bung Borapet, Nakornsawan, a future reintroduction site for *C. siamensis* in Thailand.

The Sarawak Forestry Corporate Office has indicated that it will host the second Borneo Human-Crocodile Conflict meeting in Kuching in 2011. Further details will be provided in the CSG Newsletter as they become available.

The CSG Student Research Assistance Scheme provided funding to 13 students in 2010, bringing the number of recipients since it's establishment (2009) to 33 (pages 4-5).

Professor Grahame Webb, *CSG Chairman*.

## Obituary

José Silviano Guichard Gutierrez (82 y), Alvarez del Toro's contemporary collaborator, passed away on 14 November 2010 in his native State of Chiapas, Mexico, of natural causes. Known affectionately as "Don Ché", José donated a 8 acres of natural lake on Alexandria Ranch, Juarez Municipality, to the University of Chiapas in the late 1960s. It was here that Professor Miguel Alvarez del Toro made important observations on Morelet's crocodile (*Crocodylus moreletii*) in natural habitat, which were presented in his work "The Crocodylia of Mexico, a Comparative Study" (1974).

Don Ché and Alvarez del Toro maintained a friendship that lasted until the last day of their lives. Several of the animals on display for a long time at the Miguel Álvarez del Toro Zoo, came from the Alexandria Ranch (eg crocodiles, freshwater turtles, porcupines, armadillos, etc.). Some of these specimens, such as Brown Howler Monkey, Water Opossum and Racket Bird Bat were exhibited there for the first time. Don Ché also helped to collect wild animals for the scientific collection of the Instituto de Historia Natural de Chiapas, which was the best biological collection from southern Mexico for a long time.



Figure 1. Miguel Alvarez del Toro (left) and Don Ché at Alexandria Ranch, Juarez, Chiapas State, in 1970. Photograph: courtesy of Clementina Perez de Alvarez del Toro.



Figure 2. Don Ché and CSG member Luis Sigler at Alexandria Ranch in 2003, during the development of the "COPAN" project. Photograph: Luis Sigler.

Despite being largely self-taught, Don Ché was a visionary who was ahead of his time. He devoted himself to organic agriculture and livestock, maintaining more than a third of his ranch with natural vegetation, thereby also helping to preserve the fauna of the region.

He is survived by his wife, Mrs. Delvita, and five children, who he provided with the best education and professional development. One of them, biologist Carlos Alberto Guichard, was director of the Zoo Regional Miguel Alvarez del Toro for 20 years. The CSG expresses its sincerest condolences to Don Ché's family.

Luis Sigler, *The Dallas World Aquarium, Conservation Biologist for Mexico, Central and South America*, <luis@dwazoo.com>.

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## International CSG Regional Species Meeting - Update

Dates for the International CSG Regional Species Meeting to be held at Mahidol University, Bangkok, Thailand, were recently changed to 4-6 April 2011. An excursion has been organised for 7 April.

Registration forms, with details on registration fees (\$US175 registration, \$US50 excursion), airport transportation (\$US10 arrival, \$US10 departure) and accommodation reservations (\$US100/night for 1 or 2 persons, including breakfast), are available from Tom Dacey (csg@wmi.com.au).

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## **CSG Student Research Assistance Scheme Update**

Seventeen applications for SRAS funding were received in 2010, of which 13 were successful:

1. Junior Telesforo Larreal, Universidad del Zulia, Venezuela: Conservation of American crocodile (*Crocodylus acutus*) with participation of indigenous Bari in the Maracaibo Basin, Venezuela.
2. Andres Jimenez Solera University of Estatal Distancia, Costa Rica: Population structure of *Crocodylus acutus* in wetlands of the lower river basin of the Tempisque River, Guanacaste, Costa Rica.
3. Jeremy Weaver, Texas Tech University, USA: Morphometric analysis of Antillean crocodiles.
4. Joseph Lewis, Texas A&M University, USA: Population ecology and habitat selection of an inland alligator (*Alligator mississippiensis*) population at the edge of the distribution range.
5. Guillermo Principe, Proyecto Yacare and Laboratorio de Zoología Aplicada, Santa Fe, Argentina: Enriched *Caiman latirostris* diets with selenium and Vitamin E: stress, growth and immune response.
6. Ashish Bashyal, Texas Tech University and Panamanian National Secretariat for Science, Technology and Innovation: Panama population genetics of the American

crocodile (*Crocodylus acutus*) in Coiba Marine National Park, Panama.

7. Lucía Fernández, Proyecto Yacare and Laboratorio de Zoología Aplicada, Argentina: Effect of ultraviolet radiation on the immune response of *Caiman latirostris* hatchlings.
8. Louis La Grange, University of KwaZulu-Natal, South Africa: Evaluation of *Trichinella* predilection sites in relation to infection intensity in Nile crocodiles (*Crocodylus niloticus*).
9. Diego Ortiz, Pontificia Universidad Ecuador, Ecuador: Population monitoring of Black caiman *Melanosuchus niger* and Spectacled caiman *Caiman crocodilus* in the Amazonian basin of Ecuador.
10. Adam Rosenblatt, International University of Florida, Miami, USA: Isotopic turnover rates in tissues of American alligators (*Alligator mississippiensis*).
11. Nicole Smolensky, Texas A&M University, USA: Population ecology and conservation of *Osteolaemus tetraspis* in Cameroon.
12. Stefanie Münscher, University of Pretoria, South Africa: Non-invasive monitoring of glucocorticoid metabolites in captive Nile crocodiles (*Crocodylus niloticus*).
13. Luiza Passos, Pontificia Universidade Católica de Minas Gerais, Brazil: Population ecology and behavior of *Caiman latirostris* in Pirapitinga Ecological Station, southeastern Brazil.

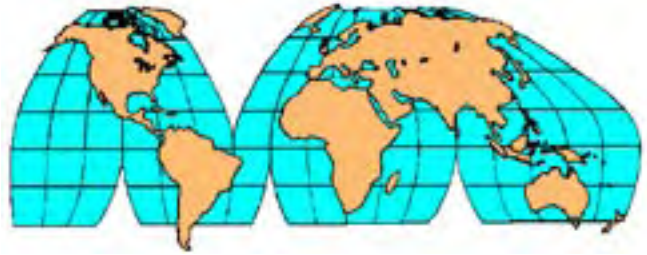
Since the SRAS program was launched in 2009, 33 students have received funding through the scheme.



Figure 1. Luiza Passos (Brazil; Project 10/13).

Tom Dacey, CSG Executive Officer <cs@wmi.com.au>.

## Regional Reports



### Latin America and the Caribbean

#### Puerto Rico

INVASIVECAIMANSMAKINGTHEMSELVESATHOME. Spectacled caimans (*Caiman crocodilus*) were introduced to Puerto Rico in the 1960s, and are now flourishing, according to a new study by the San Juan Bay Estuary Program. A dozen of the reptiles were sighted at one location, and there have been hundreds of sightings reported in the estuary. Estuary Program staff are planning to meet with Government officials in order to develop a caiman eradication program. Although the caiman are not considered dangerous to humans, they are feeding on native birds and fish.

Source: *The Associated Press*, 13 October 2010.

#### Mexico

STOCKS OF AMERICAN CROCODILE AND CAIMAN IN WETLANDS OF TONALÁ, COAST OF CHIAPAS, MÉXICO. The coastal area of Chiapas contains two of the three crocodylian species reported for Mexico. Both *Crocodylus acutus* (American crocodile) and *Caiman crocodilus* (Spectacled caiman) are listed as species subject to special protection by the NOM-059-ECOL-2001. This is important, given the ability to interact directly with humans.

Within the Municipality of Tonalá is located the sanctuary and pond system (RAMSAR) Puerto Arista. Three areas were established for sampling (Fig. 1) within the area, to quantify the status of *C. acutus* and *C. crocodilus* and to propose future management strategies, taking into account ecological, social and economic factors.



Figure 1. Survey areas (1-3) within the study area.

Of the 248 sightings, 233 (94%) were *C. crocodilus* and 15 (6%) were *C. acutus*. The distribution of the species varied between areas to some degree (Table 1), with both *C. acutus* and *C. crocodilus* in each area except Area 3, where caimans were absent, possibly due to higher salinity (>30 ppt) conditions that exist there. However, locals are aware of low numbers of caimans occurring in Area 3 at times, suggesting that other factors are possibly involved.

Table 1. Sightings recorded in each zone.

Area	Survey Distance (km)	Caiman <i>crocodilus</i>	Crocodylus <i>acutus</i>	Total Sighted
1	33	147	8	155
2	20	86	2	88
3	9	0	5	5
All	62	233	15	248



Figure 2. Capture of “Rogaciano”, a 4 m long *Crocodylus acutus*, in the study area.

#### Acknowledgments

Liliana Berenice García-Reyes (translation).

Jerónimo Domínguez-Laso, *Curator of Crocodile Museum - Secretaría del Medio Ambiente e Historia Natural - Regional Zoo “Miguel Álvarez del Toro”, Tuxtla Gutiérrez, Chiapas, México – COMAFFAS/Línea Crocodylia <museococodrilo@yahoo.com.mx>*.

## Africa

### Tanzania

**MAMMAL-LIKE CROCODILE FOSSIL DISCOVERED.** Fossils of an ancient crocodile with mammal-like teeth have been discovered in the Rukwa Rift Basin of Tanzania. Based on the teeth alone, the animal would not have been considered

a crocodile. The new species of notosuchian crocodyliform, named *Pakasuchus kapilimai*, was small and not as heavily armored as other crocodiles, except along the tail. Aspects of its anatomy suggest it was land-dwelling and likely preyed on insects and other small animals. The molar teeth of *Pakasuchus* possessed shearing edges for processing food, similar in form to the teeth of some mammalian carnivores. The creatures were abundant during the middle Cretaceous, from around 110 million until 80 million years ago.

Source: e! Science News (<http://esciencenews.com/articles/2010/08/04/mammal.crocodile.fossil.found.east.africa.scientists.report>).

## Zimbabwe

**CROCODILES ON THE ZIMBABWE STOCK EXCHANGE.** The Zimbabwe Stock Exchange (ZSE; [www.zse.co.zw](http://www.zse.co.zw)) took up its first new listing since 2007 on 29 November 2010 when Padenga Holdings Limited was admitted as the 77th ZSE listing.

Padenga Holdings has three crocodile farms in Kariba, which earn 92% of their revenue from skin exports to Asia and Europe, and 8% from meat sales to Asia. Padenga was created in September, when diversified manufacturing conglomerate Inncor divested of its crocodile skins division Niloticus, which operated as a wholly-owned asset.

On the first day of trading Padenga was reported at 2.7 million shares. The highest offer was \$US0.07 but trade opened at \$US0.05.

The global financial crisis had a negative impact on the international exotic skins market as both demand and prices declined. Subsequently, the company had to de-stock, which resulted in the business incurring a reported loss of \$US1 million during the financial year.

Sources: *African Capital Markets News* ([www.africanapitalmarketsnews.com/794/crocodile-company-swims-onto-zimbabwe-stock-exchange/](http://www.africanapitalmarketsnews.com/794/crocodile-company-swims-onto-zimbabwe-stock-exchange/)), *News Day Zimbabwe* ([www.newsdaily.co.zw/article/2010-11-29-padenga-ends-zse-listing-drought](http://www.newsdaily.co.zw/article/2010-11-29-padenga-ends-zse-listing-drought)), *Zimbabwe Herald* ([allafrica.com/stories/201011300025.html](http://allafrica.com/stories/201011300025.html)).

## Democratic Republic of Congo

**CROCODILE CAUSES PLANE CRASH.** An escaped crocodile caused a passenger plane to crash on 25 August 2010, killing 20 people on board. The Czech-made Let L-410 Turbolet crashed into a house, a few hundred metres from its destination at Bandundu.

According to the lone survivor, one of the passengers had a crocodile in his bag, which he had intended to sell. The

crocodile escaped from the bag as the plane began its descent, and the terrified air hostess and passengers rushed to the front of the plane to avoid the reptile, causing the plane to be thrown off balance. Despite the desperate efforts of the pilot, the plane flipped over and crashed.

The crocodile survived the crash, but was cut into pieces with a machete.

Source: *Daily Mail Reporter*, 26 October 2010 ([www.dailymail.co.uk/news/article-1322580/Aircraft-crashes-crocodile-escapes-killing-British-pilot-19-others.html](http://www.dailymail.co.uk/news/article-1322580/Aircraft-crashes-crocodile-escapes-killing-British-pilot-19-others.html))

## Australia and Oceania

### Australia

CROCODILE SPOTTED AT BRISBANE BEACH. The sighting of a 3 m long crocodile near a northern Brisbane beach is currently under investigation by wildlife authorities. The crocodile was sighted in Schultz Canal, heading up Jacksons Creek, near Nudgee Beach. It is very unusual for crocodiles to occur this far south on the Queensland east coast. This represents the first sighting south of the Boyne River near Gladstone since June 1905, when a large Saltwater crocodile (*Crocodylus porosus*) was shot and killed in the Logan River.

Source: *AAP*, 17 September 2010.

## East and Southeast Asia

### Cambodia

2010 MONITORING AND NEST SURVEYS REVEAL STATUS AND THREATS OF COMMUNITY-PROTECTED *CROCODYLUS SIAMENSIS* SUB-POPULATIONS IN CAMBODIA. The Cambodian Crocodile Conservation Programme (CCCP) was formed in 2000 (Daltry and Chheang 2000), upon the rediscovery of Siamese crocodiles (*Crocodylus siamensis*) during a joint Fauna & Flora International/Royal Government of Cambodia expedition to the Cardamom Mountains of southwest Cambodia. Since that time, the

CCCP has surveyed vast stretches of rivers and wetlands and have found at least 170 individual crocodiles, scattered across 35 rivers and wetlands throughout the country. Of all these sites, three in the southwest of the country were determined to have critically important breeding sub-populations: the Areng Valley, O'Som and Chhay Reap.

Since it began in 2000, the CCCP has worked closely with local communities to determine locations of critically important *C. siamensis* sub-populations. Veal Veng Marsh (O'Som) became Cambodia's first community crocodile sanctuary in 2003; and this in turn became the model for a second community crocodile sanctuary in 2005 (Areng). A third sanctuary is now being supported in the western Cardamom Mountains (Chhay Reap). A network of Community Crocodile Wardens has been established at each of these sites and has significantly reduced poaching of crocodiles and other wildlife. In addition, the project has measurably improved the livelihoods of local communities near the crocodile sanctuaries through the establishment of agriculture associations, savings groups and support to local school teachers to ensure children are receiving an education (Daltry *et al.* 2004). To determine whether these initiatives are achieving conservation objectives, annual monitoring and surveys are jointly conducted by the communities and the CCCP.

#### 2010 Annual Transect Surveys

In January and February 2010, annual transect surveys were completed in the three Siamese crocodile sanctuaries co-created and monitored by the CCCP and local communities. The first survey conducted was in Chhay Reap, Koh Kong Province, between 22 and 25 January, along the Stung Kampong Tachey and Trapeang Peang Marsh. The second survey was conducted between 31 January and 3 February, in O'Som, Pursat Province, along the Stung Khnong River. The third survey was conducted in Chhay Areng, Koh Kong Province, every four days between 3 and 28 February (13 direct crocodile sightings were made during these surveys).

Using monitoring data gathered using the same techniques during previous years, the project team concluded that *C. siamensis* sub-populations at the Areng and O'Som sites (estimated to be 40 and 50 adults respectively) have remained stable or are increasing (Simpson 2006). All dung and tracks are measured by the project team to estimate numbers of

Table 1. Results of annual transect surveys, 2001-2010. \* Areng habitat consists of sandy river bank substrate in which crocodile tracks can be detected much more easily compared to the other sites which are marsh grasslands.

Sanctuary	Signs	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Areng *	Tracks	-	33	40	0	0	31	71	58	45	68
	Dung	-	6	85	8	13	3	5	14	17	8
O'Som	Tracks	0	2	0	0	3	4	0	0	0	0
	Dung	46	78	99	42	30	51	40	5	25	60
Chhay Reap	Tracks	-	-	-	-	-	-	0	3	5	0
	Dung	-	-	-	-	-	-	16	13	11	7

individuals and data are kept on a national database.

However, the team is concerned about the status of the Chhay Reap sub-population (estimated to be 20 adults) because this has the lowest number of signs found (less than half that of previous years) and most were in one small area. Although fluctuating numbers are to be expected from transect surveys from year to year and dips in a single year may not be significant (as demonstrated in the table below), the CCCP was made aware of four crocodiles confiscated from fishermen in the past year by the Fisheries Administration of Cambodia. It is possible other crocodiles have been caught and removed undetected. Also, the remains of one crocodile were found by the project team (see below). Finally, supplemental camera trapping conducted between January and April at the site revealed high levels of human activity, including the presence of monkey-hunters, people using illegal electric-fishing equipment, brush fires and domestic buffalo.

### Threats and Mortalities

Sadly, this year the CCCP has been made aware of at least two crocodile deaths and one attempt by fishermen to capture juveniles. Community wardens at the Areng site were responsible for documenting the first recorded wild *C. siamensis* killing since 2004. During routine patrols at crocodile habitat sites on 13 February, Community Wardens encountered an illegal logging camp where they saw a crocodile skin hanging. When the Wardens returned with the police and Forestry Administration rangers to ambush the camp, the offenders had already escaped, but had left the skin behind (69 cm long; when alive the animal likely had a total length of around 1.5 m). Given the condition of the skin, it was determined by the CCCP that the offenders were amateurs: the skin was worthless and the animal alive would have earned more money if it had been sold (illegally) to a farm. This killing was likely opportunistic.

Community Wardens at the Chhay Reap site can also be credited the successful rescue of a young crocodile. On 10 February, Wardens conducting patrols along the Trapeang Peang Marsh observed a fisherman checking a fish trap, which contained a 60 cm crocodile. The Wardens confiscated the animal from the fisherman (who was not from Chhay Reap, but another village far away) and forced him to remove the trap, citing the conservation rules of the Trapeang Peang Marsh. The crocodile was released back to wild.

During extended crocodile surveys conducted in the Chhay Reap area during January 2010, the project team, acting on information from a local fisherman, found the skeleton of a large crocodile (>3 m) which was missing only its teeth. Two balls of fishing-net were found in the abdomen. The cause of death may have been drowning after being tangled in gear or, less likely, gastric complications from consuming the fishing gear. Alternatively, the crocodile may have been killed by people who removed the teeth as a souvenir or for sale. The skeleton was estimated to be two years old. The survey team collected the bones and brought them to the CCCP office to be cleaned and further examined.

Finally, one substantial threat to Siamese crocodiles at a much larger scale is hydro-electricity development. In 2003, the Royal Government launched its Rectangular Strategy for National Development. As part of this, it was determined that Cambodia had the highest rates for electricity in the region and that energy development through hydro-power was a national priority to develop the economy and encourage foreign investment. Since this time, approximately 14 hydro-power projects have been studied, including five within the Cardamom Mountains of southwest Cambodia, of which two directly threaten the O'Som and Areng sub-populations, in spite of their protected status. Construction has already begun at O'Som while the Areng remains in limbo as the Royal Government of Cambodia negotiates with private investors. The Areng will be particularly affected as the dam reservoir has been estimated to be up to 10,000 ha and will inundate the existing habitat in its entirety. The CCCP has already begun *ex situ* activities by developing a breeding programme at the Phnom Tamao Wildlife Rescue Centre (Starr *et al.* 2009) and initiating mitigation planning which will likely involve translocation of crocodiles to safe sites.

### Nest Surveys and Successful Hatching

Nest surveys were conducted on 27-29 April 2010 at three oxbow lakes at the Areng site, and the team located one nest with 22 eggs (15 fertile). Each egg was measured and candled to determine fertility. Because nests in this area have in the past been destroyed by wild animals and flooding in the past, the team carefully moved the 15 fertile eggs to an artificial nest at the base camp for head-starting (this is the second time community members in Areng have been involved with assisting in head-start activities). A protective fence was put up around this artificial nest and 24-hour guarding was implemented to ensure none of the eggs were preyed upon or stolen before they hatched. In addition, a Reconyx digital camera trap was set up at the natural nest site to monitor any activities (Fig. 1).

On 3 June, 10 hatchlings emerged from the head-start nest and three from a natural nest. In addition to the success of this nest hatching, the camera trap was also able to take what are believed to be the first images of a wild *C. siamensis* female guarding her nest in Cambodia (and perhaps the first in all of Southeast Asia) (Fig. 1).

As means to monitor the growth and health of these animals, they were measured and scute-clipped for future identification. The 10 hatchlings from the head-start nest remain with community crocodile wardens until they are (i) large enough to be returned to wild without fear of predation and (ii) a suitable release site can be identified that is not under risk of hydro-electricity development.

### Conclusions

As part of its conservation efforts, the CCCP has established multi-faceted community based conservation activities at each of these sites including establishing community-managed sanctuaries, education programs and promoting sustainable



livelihoods. Monitoring and surveys have been conducted at O'Som since 2001, Areng since 2002, and Chhay Reap since 2007. The authors believe that the success of these cumulative community-based activities are reflected above as overall results from annual transect surveys appear to indicate that Siamese crocodile sub-populations at the first two sites are stable, if not modestly increasing. However, events over the past year, either reported to or observed by the CCCP at the Chhay Reap site, have made the project team concerned with the lower numbers recorded and may serve as a warning to the other sites and other species. The project team will need to pay particular attention to this site during subsequent transect surveys in order to determine whether these concerns are warranted.

Despite the apparent successes of this community-based approach with crocodile conservation in Cambodia, the reality of these sub-populations being eradicated looms on the horizon. Economic forces related to national development, particularly hydro-electricity development, create a threat unlike any other previously known to crocodile conservation in Cambodia. Without sound mitigation plans being developed and implemented, as well as *ex situ* breeding and re-introduction to safe sites, the Siamese crocodile face a dire future. Real success will not be achieved in preventing this species from once again being declared "Effectively Extinct in the Wild" unless all relevant government agencies and conservation organizations are able to effectively cooperate and work together in Cambodia to achieve the common goal of saving the Siamese crocodile.



Figure 1. Camera trap image of wild female *C. siamensis* approaching (above) and at (below) her nest.

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Adam Starr, *CCCP Programme Manager, Fauna & Flora International (adamstarr.ffi@gmail.com)*; Sam Han, *CCCP Field Coordinator (former), Forestry Administration of the Royal Government of Cambodia (samhanwpo@yahoo.com)*; and, Dr. Jenny Daltry, *CCCP Programme Advisor and FFI Senior Biologist, Fauna & Flora International (jenny.daltry@gmail.com)*.

## South Asia and Iran

### India

The following Executive Summary is reproduced, with editorial modifications, from "The Muggers (*Crocodylus palustris*) of Vishwamitri River: Past and Present", authored by Dr. Raju Vyas. The work was published by Mr. Sanat Mheta (President of Srt. Aruna Mehta Memorial Trust and ex-Finance Minister of Gujarat State, Vadodara) and released on 8 December 2010 by Mr. Kartik Sarabhai (Director, Centre for Environment Education) and Mr. Lavekumar Khacher (Indian naturalist) (Fig. 1). The publication documents 25 years of working with Mugger (*Crocodylus palustris*) by Dr. Vyas in Gujarat State, India.

This report is the result of a compilation from various sources and 22 years (1987-2009) of monitoring of the Mugger (*Crocodylus palustris*) population in the Vishwamitri River. The Mugger is legally protected under the *Indian Wildlife (Protection) Act* as a Schedule-I species and evaluated as Vulnerable by the IUCN.

A highly adaptable species, *C. palustris* is found in various habitats, including large rivers, large lakes, small puddles,

village tanks and roadside ditches. In the late 1960s, the species was depleted from its entire range due to illegal hunting, fishing and habitat loss. With legal protection and *ex situ* programs the population flourished and the species returned from the brink of extinction. Relative to the other two Indian crocodylian species, the Mugger population is sound. Over 3500 muggers are estimated to be in India, with notable numbers in the States of Tamil Nadu, Kerala, Maharashtra, Goa, Uttar Pradesh, Orissa, Gujarat and Rajasthan.

Mugger are recorded from most parts of Gujarat State, and occur in 15 of 26 districts. Notable populations were recorded at Kutch, Junagadh, Porbandar, Kheda, Vadodara, Bharuch, Narmada and Jamnagar Districts. Also, Mugger inhabit the Rukmavati, Khari, Tapi, Narmada, Mahi, Vishwamitri and Shentrunji Rivers. A 1995-96 survey estimated 1650 animals in the State. Most of the Mugger population and its habitat are secure and safe. Mugger is found commonly in many water bodies of the state and some of the population is saturated and has dispersed, creating a problem and finally resulting in man and animal conflicts.

A small Mugger population is flourishing in the seasonal Vishwamitri River, which originates from Pavagadh hills, flows through Vadodara City, and meets the Arabian Sea in the Gulf of Khambhat. In the 1960-70s about 50 animals were noted in Sayaji Sarovar, located upstream. During the 1970s, few animals migrated to the downstream Vishwamitri River near Vadodara City. Presently this sewage-polluted river is a home to a small population of muggers.

Five censuses have been made in the study area, with day-basking method employed in 1993, 1995 and 2008-09, and night count method in 2001 and 2007. These survey results indicate an increase in the Mugger population over a 22-year period, from 9 animals recorded in 1993 to 81 animals in 2009 - an 800% increase. Density increased from 0.36/km to 4.0/km and 3.5/km in 2007 and 2009 respectively.

A total of 9 burrows was recorded in the area in 1995, all behind the palace compound on the left banks of the river in 'Segment-3' (8 at water level one 1.5 m above water level). In the same river stretch, 40 burrows were noted in 2009, including 15 on the right banks and 25 on the left banks of the river. Of these, 36 burrows were active and being used. The highest number of burrows (29) was observed in Segment-3, and the lowest number (2) at Segment-4 (downstream). Most burrows are close to water, lying almost at water level. Eleven burrows were at varying heights (3-5 m) above water level. Most burrows are found on stiff river banks, along with good vegetation cover, and are difficult to approach.

Foraging activities of Muggers are observed in early morning and late evening. Eight species of birds were noted as a diet of Mugger, with Blue Rock Pigeon (*Columba livia*), Red Wattles Lapwing (*Vanellus indicus*) and Black-winged Stilt (*Himantopus himantopus*) being commonly preyed upon. Muggers often attack domestic livestock, including poultry, goats and dogs. Hatchlings and juvenile Muggers are observed feeding on frogs and insects, including Indian Skipping Frog

(*Euphlyctis cyanophlyctis*), Indian Bullfrog (*Hoplobatrachus tigerinus*) and dragonfly (*Odonata* sp.).

Mugger nesting sites and activities are observed in all segments except Segment-I in the upstream area. Nesting sites are recorded behind the Sayaji Baug Zoo in Segment-II, near Bhimnath bridge, behind the Fast-track Court, near Muj-Mahuda bridge in Segment-III and near Kalali village at Segment-IV. These sites are used by a few females for nesting activity, usually noticed each year. Hatchling success was not recorded in the study, but a small number of hatchlings and juveniles was recorded in the four mugger surveys. Fifty percent of hatchlings and juveniles have been rescued from human habitation, a clear indication of the low hatchling success every year in the area. However, gradual growth of the Mugger population in the area and records of various age-classes of Muggers indicate the success of hatchlings and new recruits.

Natural nest and egg predation is noted by indirect evidence of tracks of predators, including domestic dogs (*Canis* sp.), Jackals (*Canis aureus*) and Monitor lizards (*Varanus bengalensis*). From 1995 to 2005, 8 nests were predated by dogs, Jackals and Monitor lizards at Sayaji Garden in Segment- II.

Various government organizations, non-government organizations and some volunteers are actively involved in Mugger rescue work. A total of 321 Muggers were rescued from in and around the city between 1987 and 2009, including 111 small (<1 m), 164 medium (1-2 m) and 46 large (>2 m) individuals. Most (84%) were rescued in the last decade. All rescued crocodiles were scute-clipped before transfer/release in Sayaji Sarovar at Ajwa, except for a few released at some other water bodies. Analysis of rescue data indicates the highest number of animals (73) in August and the lowest (4) in May. There is a positive trend with the rainy season. With the onset of monsoons, Muggers are observed to make more regular appearances in areas of human habitation. Encounters with Muggers become frequent during or after floods. Some released muggers come down repeatedly in the same river stretch from their release site. One of the best examples of homing was a female Mugger (no. 56) which was captured 8 times, until it was run over by a train as it crossed railway tracks.

From 1995 to 2009, 19 Mugger attacks occurred in the river system, of which 7 were reported in the study area itself. Eight incidents were fatal (all male victims). Victims were 4 young boys (9-16 y), 5 women (30-45 y) and 10 men (21-45 y). In all but one attack near Virjay village, the victim's bodies were recovered intact. Most of the female victims were attacked while washing clothes at the water's edge, and males were attacked during fishing activities and crossing rivers. There has been an average of 2.8 incidents per year over the last 5 years.

Most citizens have a great reverence towards the animals, but when Muggers are found in and around residential areas, citizens are terrified and immediately call for help to get rid of

the animal. But in few cases, people are so terrified that they kill or attempt to kill the animal themselves and throw the carcass into nearby waterbodies/garbage or at times burn it to avoid legal consequences. During the last two decades, official and non-official records show 17 killed and four severely injured Muggers of various age/size groups. All incidences of injured Mugger were from areas of human habitation, indicating the strong dislike and intolerant attitude of rustic-minded urban inhabitants ruthlessly injuring the crocodiles and assaulting the animals in such situation. It depicts the perception of society towards the species.

There are a number of threats on the population. The existence of such large reptiles amidst a densely populated urban scenario results in threats of river pollution and encroachment on the river banks. With a 4.4-fold increase in the number of adult Mugger in the heart of the city over the last 15 years, this is a potentially dangerous problem for both humans and Muggers, and which requires a solution.

The killing and/or injuring of Muggers confirms the negative and non-cooperative thinking of some locals who are not in favor of Mugger conservation but are riled towards the local authority and NGOs. This can only be reduced or minimized by an awareness program on Mugger conservation. Presently, Sayaji Sarovar is not an ideal location for release of Muggers, as they continue to return to their site of capture - new release sites need to be identified.

The Mugger population in the Vishwamitri River, especially in and around Vadodara City, should be preserved, as it provides a unique, ideal and complex case study of man and animals living in harmony, and an extraordinary example of crocodile conservation. The survival of Mugger in the Vishwamitri River is the one of symbols of culture of the land and great reverence towards the species by the society.

But can this mugger population survive long-term? This is possible if and only if proper measures are taken by the State forest and urban authority along with the positive willingness of locals. Otherwise this small population of Muggers will disappear.



Figure 1. Official release of “The Muggers (*Crocodylus palustris*) of Vishwamitri River: Past and Present”. From left: Dr. Raju Vyas (author), Mr. Kartik Sarabhai, Mr. Lavekumar Khacher and Mr. Sanat Mheta (see text).

**Report Citation:** Vyas, R. (2010). The Muggers (*Crocodylus palustris*) of Vishwamitri River: Past and Present. Herpetology & Environmental Research Project (HERP): Vadodara.

An electronic version of the report can be obtained directly from Dr. Raju Vyas (razoovyas@hotmail.com).

**NEW INITIATIVE FOR GHARIAL CONSERVATION.** The Indian Minister for Environment and Forests, Mr. Jairam Ramesh, visited the Madras Crocodile Bank on 27 December, spending an hour with Rom Whitaker and MCB staff. A considerable body of the press and electronic media was briefed by Mr. Ramesh on the Ministry’s new initiative for Gharial conservation. He described the Gharial as India’s most endangered species, more endangered than the tiger, elephant or leopard and the need to take immediate and bold steps to make sure the Gharial doesn’t go the way of the Indian cheetah.

As most of the Chambal River lies within the National Chambal Sanctuary, and is the largest repository of the Critically Endangered Gharial, Mr. Ramesh announced the formation of a National Tri-State Chambal Sanctuary Management and Coordination Committee for Gharial conservation. The Committee will consist of representatives of relevant Ministries, such as Water Resources, State Departments of Irrigation and Power, Wildlife Institute of India, Madras Crocodile Bank Trust/Gharial Conservation Alliance, Development Alternatives, Ashoka Trust for Research in Ecology and the Environment, Worldwide Fund for Nature and the Divisional Forest officers of the three States.

The Committee will chalk out strategies for both Gharial and habitat protection, which will involve further research on the species and its ecology and socio-economic evaluation of dependent riparian communities. Support for this new, dynamic initiative will be mobilized as a sub-scheme of the ‘Integrated Development of Wildlife Habitats’ to the tune of Rs.50-80 million (\$US1.0-1.7 million) each year for five years. Mr. Ramesh said that his Ministry has ruled out the construction of any further dams on the Chambal River and made a general plea to stop polluting and misusing rivers in India for the sake of the Gharial, river dolphin and ultimately the people dependent on river water for their survival.

Madras Crocodile Bank/Gharial Conservation Alliance

## Science



### **Recent Publications**

Campbell, H.A., Dwyer, R.G., Gordos, M. and Franklin, C.E. (2010). Diving through the thermal window: implications for a warming world. Proceedings of the Royal Society B.

**Abstract:** Population decline and a shift in the geographical distribution of some ectothermic animals have been attributed to climatic warming. Here, we show that rises in water temperature of a few degrees, while within the thermal window for locomotor performance, may be detrimental to diving behaviour in airbreathing ectotherms (turtles, crocodylians, marine iguanas, amphibians, snakes and lizards). Submergence times and internal and external body temperature were remotely recorded from freshwater crocodiles (*Crocodylus johnstoni*) while they free-ranged throughout their natural habitat in summer and winter. During summer, the crocodiles' mean body temperature was  $5.2 \pm 0.18^{\circ}\text{C}$  higher than in winter and the largest proportion of total dive time was composed of dive durations approximately 15 min less than in winter. Diving beyond 40 min during summer required the crocodiles to exponentially increase the time they spent on the surface after the dive, presumably to clear anaerobic debt. The relationship was not as significant in winter, even though a greater proportion of dives were of a longer duration, suggesting that diving lactate threshold (DLT) was reduced in summer compared with winter. Additional evidence for a reduced DLT in summer was derived from the stronger influence body mass exerted upon dive duration, compared to winter. The results demonstrate that the higher summer body temperature increased oxygen demand during the dive, implying that thermal acclimatization of the diving metabolic rate was inadequate. If the study findings are common among air-breathing diving ectotherms, then long-term warming of the aquatic environment may be detrimental to behavioural function and survivorship.

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Buden, D.W. and Haglelgam, J. (2010). Review of crocodile (Reptilia: Crocodylia) and dugong (Mammalia: Sirenia) Sightings in the Federated States of Micronesia. Pacific Science 64(4): 577-583.

**Abstract:** Three confirmed occurrences of crocodiles, one identified as *Crocodylus porosus* (two others presumed *C. porosus*), and four occurrences of the dugong, Dugong dugon, are recorded for the Federated States of Micronesia. The records of a crocodile and a dugong on Eauripik Atoll and a dugong on Kosrae are reported in the literature for the first time. On geographic grounds, the crocodiles and dugongs recorded from Yap State, in the western part of the FSM, probably pertain to vagrants from Palau, approximately 450 km to the southwest, whereas those recorded from the eastern islands (Pohnpei and Kosrae) are more likely to have originated from populations in the Bismarck Archipelago and Solomon Islands area, approximately 1500 km to the southwest, rather than from Palau, which is a much greater distance to the west.

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Yun Hu and Xiao-Bing Wu (2010). Multiple paternity in Chinese alligator (*Alligator sinensis*) clutches during a reproductive season at Xuanzhou Nature Reserve. Amphibia-Reptilia 31: 419-424.

**Abstract:** Paternity testing was determined in Chinese

alligator (*Alligator sinensis*) clutches during a reproductive season at Xuanzhou Nature Reserve, using 5 microsatellite loci. DNA from 10 mother and offspring clutches was analysed to identify paternal alleles. Three or four paternal alleles were observed among 3 of 10 clutches. These clutches were sired by at least two different males. This present study confirmed the effectiveness of microsatellite DNA markers in detecting multiple paternity within natural populations of Chinese alligator. However, to reduce the confounding effects of mutations and null alleles on allele assignment and to increase power to monitor individual's genetic contribution, we need additional variable genetic markers.

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Mena-Cevasco, J., Espinosa-Blanco, A. and Seijas, A. (2010). Population analysis of Orinoco crocodile in the Cojedes River system, Venezuela. Rev. Unell. Cienc. Tec. (Volumen Especial): 14-19.

*Crocodylus intermedius* is a species of crocodile whose distribution is restricted to the Orinoco River basin. Today this species is found in only a fraction of its original range. It is listed in critical danger of extinction by the IUCN and in the Red Book of the Venezuelan fauna. As a contribution to the conservation program of the Orinoco crocodile in Venezuela, its abundance and population structure was determined in two sections of the Cojedes River system: Batea-Confluencia (5.9 km) and Merecure Cano-Amarillo (12.3 km). From March to April 2009 spotlight counts and capture of individuals were conducted. The higher population index was obtained in Batea-Confluencia (7.8 ind/km) and the size V individuals (adults) were dominant, with 21 individuals. This research compiled important information on the population status of the species in Cojedes River system, as a support for the division as area under special administration towards the conservation of the species.

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Dinets, V. (2010). Nocturnal behaviour of American alligator (*Alligator mississippiensis*) in the wild during the mating season. Herpetological Bulletin 111: 4-11.

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Campos, Z., Sanaiotti, T. and Magnusson, W.E. (2010). Maximum size of dwarf caiman, *Paleosuchus palpebrosus* (Cuvier, 1807), in the Amazon and habitats surrounding the Pantanal, Brazil. Amphibia-Reptilia 31: 439-442.

**Abstract:** The dwarf caiman, *Paleosuchus palpebrosus*, is considered one of the smallest crocodylians. However, our surveys indicate that the species regularly reaches larger sizes than usually reported in the literature. Most individuals lose tail tips, and we did not encounter any individual with snout-vent length (SVL) >70 cm that had an intact tail. *P. palpebrosus* attains SVL >112.5 cm (equivalent to a total length with intact tail estimated from SVL of 210 cm) in streams around the Pantanal, 106 cm (198 cm) in flooded forest in central Amazonia, and 100 cm (187 cm) in flooded forest and around the Madeira-Guaporé River.

Espinal, M.R., Mora, J.M. and Leiva, F. (2010). Abundance and distribution of the American crocodile (*Crocodylus acutus*) at El Cajon Reservoir, Honduras, and the development of an integrated management plan for conservation. Pp. 734-745 in Conservation of Mesoamerican Amphibians and Reptiles, ed. by L.D. Wislon, J.H. Townsend and J.D. Johnson. Eagle Mountain Publishing: Eagle Mountain, Utah.

**Abstract:** Two of us (ME, FL) conducted nocturnal surveys of the American Crocodile (*Crocodylus acutus*) at Represa Hidroeléctrica Francisco Morazan, El Cajon (= El Cajon Reservoir) in May and June of 2005. We recorded more individuals in May (1071) than in June (523), and observed from 98 to 223 crocodiles per day in May and from 38 to 161 in June. The difference in the numbers of crocodiles seen during this period likely resulted from fluctuations in the water level of the reservoir. In each month, we recorded the majority of crocodiles along the Sulaco and Humuya Rivers. Based on estimates of individual total length, the population structure of *C. acutus* at the reservoir was as follows. In May 50% neonates, 4.2% yearlings, 7.7% juveniles, 21.5% sub-adults and 8.4% adults, and in June, 36.1% neonates, 2.1% yearlings, 7.1% juveniles, 25.6% sub-adults and 13.2% adults. Such a population structure is typical for a growing population. We estimated the density of *C. acutus* at the reservoir from 3.8 to 7.9 ind/km. The highest density was along the Sulaco and Humuya Rivers, with respective values of 10.8 and 12.2 ind/km in May and 5.2 and 5.6 ind/km in June. Also, we identified potential nesting sites along the study area and located a total of 30 nests, as follows: Rio Humuya (16), Rio Sulaco (12), and Rio Yure (two). We encountered most individuals along side channels called “chutes”, areas that offer *C. acutus* the best protection within the emergent vegetation. At El Cajon, threats to the *C. acutus* population and the habitat include an uncontrolled fishing industry, the presence of cattle and agriculture, and fish farming. To secure additional information on the threats, we initiated a mark-recapture program to monitor the population dynamics of the crocodiles and marked 39 individuals of various size classes. After completing this study, we presented information on the capture, marking and management of crocodiles to personnel from El Cajon, AQUAFINCA and representatives of the local community. Our goal was to establish a long-term monitoring program for *C. acutus* at the reservoir, as well as to develop a management plan for the crocodiles and their habitat.

In our ongoing efforts to monitor the population of *C. acutus* at El Cajon, in June of 2007 we (ME, JM, FL) conducted another survey, which was less extensive than the one in 2005. During the survey we encountered 87 individuals in the Rio Humuya and 64 in the Rio Yure, and the population structure consisted of 0% neonates, 31.8% yearlings, 10.6% juveniles, 29.8% sub-adults and 9.3% adults. The reason for not encountering any neonates remains unclear, but the dense vegetation at the reservoir at that time of the year is a possible explanation.

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Campbell, J.W., Waters, M.N., Tarter, A. and Jackson, J. (2010). Heavy metal and selenium concentrations in liver tissue from

wild American alligator (*Alligator mississippiensis*) livers near Charleston, South Carolina. J. Wildl. Dis. 46(4): 1234-1241.

**Abstract:** Liver samples from 33 wild American alligators (*Alligator mississippiensis*) livers from the Charleston, South Carolina, area were analyzed for arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), and selenium (Se) concentrations. Alligators are top predators and are considered a good biomonitoring species for various toxins, including heavy metals. Alligators from other areas in the USA have shown high concentrations of mercury and other heavy metals, but the Charleston area, which is highly industrialized, has not been investigated. We found wide variation in hepatic heavy metal and selenium concentrations among alligators. Length and sex did not show a strong relationship with any metal based on statistical analysis. However, cluster analysis revealed three groupings of alligators based on liver metal concentrations. Alligators with low Se:Hg ratios also had high concentrations of Hg. Due to the wide variation in metal concentrations among individual alligators, we postulate that individual diet and microhabitat usage could be the cause for this variation.

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Roh, Y.S., Park, H., Cho, A., Islam, M.R., Chekarova, I., Ejaz, S.E., Lim, C.W. and Kim, B. (2010). Granulomatous pneumonia in a captive freshwater crocodile (*Crocodylus johnstoni*) caused by *Mycobacterium szulgai*. J. Zoo Wildl. Med. 41(3): 550-554.

**Abstract:** A 25-year-old male freshwater crocodile (*Crocodylus johnstoni*) was diagnosed with pulmonary mycobacteriosis caused by *Mycobacterium szulgai*. Necropsy revealed fibrinous exudate in the right pleural cavity and white miliary nodules in the right lung lobe. Histopathologic examination revealed well-demarcated granulomas consisting of multinucleated giant cells and epithelioid cells surrounded by fibrous connective tissue. Atypically, lymphocytes had accumulated in the outer region of fibrous connective tissue. Mycobacterial infection was confirmed by nested polymerase chain reaction targeting the hsp65 gene and by Fite's method for detection of acid-fast bacilli within formalin-fixed, paraffin-embedded lung tissue. Sequence analysis of the DNA amplicon revealed that the species of mycobacterium shared 98% homology with the gene encoding the hsp65 gene of *M. szulgai*. This is the first report of *M. szulgai* as the causative agent of mycobacteriosis in a reptile.

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Gribbins, K.M., Siegel, D.S., Anzalone, M.L., Jackson, D.P., Venable, K.J., Rheubert, J.L. and Elsey, R.M. (2010). Ultrastructure of spermiogenesis in the American alligator, *Alligator mississippiensis* (Reptilia, Crocodylia, Alligatoridae). J. Morphol. 271(10): 1260-1271.

**Abstract:** Testicular samples were collected to describe the ultrastructure of spermiogenesis in *Alligator mississippiensis* (American alligator). Spermiogenesis commences with an acrosome vesicle forming from Golgi transport vesicles.

An acrosome granule forms during vesicle contact with the nucleus, and remains posterior until mid to late elongation when it diffuses uniformly throughout the acrosomal lumen. The nucleus has uniform diffuse chromatin with small indices of heterochromatin, and the condensation of DNA is granular. The subacrosome space develops early, enlarges during elongation, and accumulates a thick layer of dark staining granules. Once the acrosome has completed its development, the nucleus of the early elongating spermatid becomes associated with the cell membrane flattening the acrosome vesicle on the apical surface of the nucleus, which aids in the migration of the acrosomal shoulders laterally. One endonuclear canal is present where the perforatorium resides. A prominent longitudinal manchette is associated with the nuclei of late elongating spermatids, and less numerous circular microtubules are observed close to the acrosome complex. The microtubule doublets of the midpiece axoneme are surrounded by a layer of dense staining granular material. The mitochondria of the midpiece abut the proximal centriole resulting in a very short neck region, and possess tubular cristae internally and concentric layers of cristae superficially. A fibrous sheath surrounds only the axoneme of the principal piece. Characters not previously described during spermiogenesis in any other amniote are observed and include (1) an endoplasmic reticulum cap during early acrosome development, (2) a concentric ring of endoplasmic reticulum around the nucleus of early to middle elongating spermatids, (3) a band of endoplasmic reticulum around the acrosome complex of late developing elongate spermatids, and (4) midpiece mitochondria that have both tubular and concentric layers of cristae.

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Viana, L.A., Soares, P., Paiva, F. and Lourenço de Oliveira, R. (2010). Caiman-biting mosquitoes and the natural vectors of *Hepatozoon caimani* in Brazil. *J. Med. Entomol.* 47(4): 670-676.

**Abstract:** Mosquitoes that feed on crocodylians are poorly known, despite the potential role of these exothermic animals as reservoirs of arboviruses. In this article, we assessed the frequency, abundance, and temporal variation of caiman-biting mosquitoes as well as searched for the natural vectors of the blood parasite of caimans, *Hepatozoon caimani*, in the Pantanal area of central-western Brazil from captures conducted bimonthly from September 2006 to September 2007 and in February 2008. A total of 5272 mosquitoes belonging to 10 species of five genera was caught on caimans. The most abundant species were *Culex (Melanoconion) theobaldi*, *Mansonia (Mansonia) titillans*, *Mansonia (Man.) humeralis*, and *Mansonia (Man.) amazonensis*, which together accounted for 80% of all sampled individuals. Other blood-feeding *Melanoconion* species were also found quite frequently on caimans, including *Culex clarki*, *Culex idottus*, and *Culex bastagarius*. Oocysts of *H. caimani* were exclusively detected in *Culex* species, mainly in individuals of the subgenus *Melanoconion*, and we accomplished experimental transmission from naturally infected mosquitoes to uninfected *Caiman yacare*. The highest infection rates were observed in *Cx. theobaldi* (0.55%), which is therefore

indicated as the primary vector of *H. caimani*. In addition, because the above mentioned *Melanoconion* and *Mansonia* species are abundant, widespread, and have a broad set of hosts, including crocodylians, they may be suggested as potential vectors of arboviruses, such as West Nile virus, in the Southern Cone in South America.

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Vicente-Neto, J., Bressan, M.C., Faria, P.B., E. Vieira, J.O., Cardoso, M.G., Glória, M.B. and da Gama, L.T. (2010). Fatty acid profiles in meat from *Caiman yacare (Caiman crocodilus yacare)* raised in the wild or in captivity. *Meat Sci.* 85(4): 752-758.

**Abstract:** Chemical composition and fatty acid profiles were determined in *Caiman yacare* meat originating from the neck and tail cuts of animals raised in the wild (n= 6) or in captivity (n= 6), slaughtered at a live weight of approximately 6 kg. All experimental methods were approved by the appropriate environmental protection agencies. Most chemical components were affected by the origin-cut interaction, with the tail cut of wild animals having the highest amount of intramuscular fat (19.2% of DM) and the lowest of moisture (71.8%) and protein (77.0% of DM). Yacare meat had low amounts of SFA (35.1%), which were similar (P>0.05) in the cuts and origins studied. The total amount of PUFA was higher (P<0.05) in wild (31.0%) than in captive animals (23.6%), and n-3 fatty acids had means of about 5% and 2% for the same groups, respectively (P<0.05). In general, the FA profile of intramuscular fat in yacare meat had a desirable PUFA/SFA ratio above 0.4.

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Elperin, A.B., Pore, S.A., Evans, J.M., Naditz, A.L. and Light, D.B. (2010). Swelling-induced Ca(2+) influx and K (+) efflux in American alligator erythrocytes. *J. Membr. Biol.*

**Abstract:** The American alligator can hibernate during winter, which may lead to osmotic imbalance because of reduced kidney function and lack of food consumption during this period. Accordingly, we hypothesized that their red blood cells would have a well-developed regulatory volume decrease (RVD) to cope with the homeostatic challenges associated with torpor. Osmotic fragility was determined optically, mean cell volume was measured by electronic sizing, and changes in intracellular Ca(2+) concentration were visualized using fluorescence microscopy and fluo-4-AM. Osmotic fragility increased and the ability to regulate volume was inhibited when extracellular Na(+) was replaced with K(+), or when cells were exposed to the K(+) channel inhibitor quinine, indicating a requirement of K(+) efflux for RVD. Addition of the ionophore gramicidin to the extracellular medium decreased osmotic fragility and also potentiated volume recovery, even in the presence of quinine. In addition, hypotonic shock (0.5× Ringer) caused an increase in cytosolic Ca(2+), which resulted from Ca(2+) influx because it was not observed when extracellular Ca(2+) was chelated with EGTA (ethylene glycol-bis(2-aminoethylether)-N,N,N',N'-tetraacetic acid). Furthermore, cells loaded with BAPTA-AM (1,2-bis(2-aminophenoxy)meth

yl)ethane-N,N,N',N'-tetraacetic acid tetrakis(acetoxymethyl ester) or exposed to a low Ca(2+)-EGTA hypotonic Ringer had a greater osmotic fragility and also failed to recover from cell swelling, indicating that extracellular Ca(2+) was needed for RVD. Gramicidin reversed the inhibitory effect of low extracellular Ca(2+). Finally, and surprisingly, the Ca(2+) ionophore A23187 increased osmotic fragility and inhibited volume recovery. Taken together, our results show that cell swelling activated a K(+) permeable pathway via a Ca(2+)-dependent mechanism, and this process mediated K(+) loss during RVD.

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Reed, D.A., Porro, L.B., Iriarte-Diaz, J., Lemberg, J.B., Holliday, C.M., Anapol, F. and Ross, C.F. (2011). The impact of bone and suture material properties on mandibular function in *Alligator mississippiensis*: testing theoretical phenotypes with finite element analysis. *J. Anat.* 218(1): 59-74.

**Abstract:** The functional effects of bone and suture stiffness were considered here using finite element models representing three different theoretical phenotypes of an *Alligator mississippiensis* mandible. The models were loaded using force estimates derived from muscle architecture in dissected specimens, constrained at the 18th and 19th teeth in the upper jaw and 19th tooth of the lower jaw, as well as at the quadrate-articular joint. Stiffness was varied systematically in each theoretical phenotype. The three theoretical phenotypes included: (i) linear elastic isotropic bone of varying stiffness and no sutures; (ii) linear elastic orthotropic bone of varying stiffness with no sutures; and (iii) linear elastic isotropic bone of a constant stiffness with varying suture stiffness. Variation in the isotropic material properties of bone primarily resulted in changes in the magnitude of principal strain. By comparison, variation in the orthotropic material properties of bone and isotropic material properties of sutures resulted in: a greater number of bricks becoming either more compressive or more tensile, changing between being either dominantly compressive or tensile, and having larger changes in the orientation of maximum principal strain. These data indicate that variation in these model properties resulted in changes to the strain regime of the model, highlighting the importance of using biologically verified material properties when modeling vertebrate bones. When bones were compared within each set, the response of each to changing material properties varied. In two of the 12 bones in the mandible, varied material properties within sutures resulted in a decrease in the magnitude of principal strain in bricks adjacent to the bone/suture interface and decreases in stored elastic energy. The varied response of the mandibular bones to changes in suture stiffness highlights the importance of defining the appropriate functional unit when addressing relationships of performance and morphology.

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Bonnan, M.F., Sandrik, J.L., Nishiwaki, T., Wilhite, D.R., Elsey, R.M. and Vittore, C. (2010). Calcified cartilage shape in archosaur long bones reflects overlying joint shape in stress-bearing elements: Implications for nonavian dinosaur locomotion. *Anat. Rec. (Hoboken)* 293(12): 2044-2055.

**Abstract:** In nonavian dinosaur long bones, the once-living chondroepiphysis (joint surface) overlay a now-fossilized calcified cartilage zone. Although the shape of this zone is used to infer nonavian dinosaur locomotion, it remains unclear how much it reflects chondroepiphysis shape. We tested the hypothesis that calcified cartilage shape reflects the overlying chondroepiphysis in extant archosaurs. Long bones with intact epiphyses from American alligators (*Alligator mississippiensis*), helmeted guinea fowl (*Numida meleagris*), and juvenile ostriches (*Struthio camelus*) were measured and digitized for geometric morphometric (GM) analyses before and after chondroepiphysis removal. Removal of the chondroepiphysis resulted in significant element truncation in all examined taxa, but the amount of truncation decreased with increasing size. GM analyses revealed that *Alligator* show significant differences between chondroepiphysis shape and the calcified cartilage zone in the humerus, but display nonsignificant differences in femora of large individuals. In *Numida*, GM analysis shows significant shape differences in juvenile humeri, but humeri of adults and the femora of all guinea fowl show no significant shape difference. The juvenile *Struthio* sample showed significant differences in both long bones, which diminish with increasing size, a pattern confirmed with magnetic resonance imaging scans in an adult. Our data suggest that differences in extant archosaur long bone shape are greater in elements not utilized in locomotion and related stress-inducing activities. Based on our data, we propose tentative ranges of error for nonavian dinosaur long bone dimensional measurements. We also predict that calcified cartilage shape in adult, stress-bearing nonavian dinosaur long bones grossly reflects chondroepiphysis shape.

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Darville, L.N., Merchant, M.E., Hasan, A. and Murray, K.K. (2010). Proteome analysis of the leukocytes from the American alligator (*Alligator mississippiensis*) using mass spectrometry. *Comp. Biochem. Physiol. Part D. Genomics Proteomics* 5(4): 308-316.

**Abstract:** Mass spectrometry was used in conjunction with gel electrophoresis and liquid chromatography, to determine peptide sequences from American alligator (*Alligator mississippiensis*) leukocytes and to identify similar proteins based on homology. The goal of the study was to generate an initial database of proteins related to the alligator immune system. We have adopted a typical proteomics approach for this study. Proteins from leukocyte extracts were separated using two-dimensional gel electrophoresis and the major bands were excised, digested and analyzed by on-line nano-LC MS/MS to generate peptide sequences. The sequences generated were used to identify proteins and characterize their functions. The protein identity and characterization of the protein function were based on matching two or more peptides to the same protein by searching against the NCBI database using MASCOT and Basic Local Alignment Search Tool (BLAST). For those proteins with only one peptide matching, the phylum of the matched protein was considered. Forty-three proteins were identified that exhibit sequence similarities to proteins from other vertebrates. Proteins related to the cytoskeletal system were the most abundant proteins

identified. These proteins are known to regulate cell mobility and phagocytosis. Several other peptides were matched to proteins that potentially have immune-related function.

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Rider, C.V., Hartig, P.C., Cardon, M.C., Lambright, C.R., Bobseine, K.L., Guillette, L.J. Jr., Gray, L.E. Jr. and Wilson, V.S. (2010). Differences in sensitivity but not selectivity of xenoestrogen binding to alligator versus human estrogen receptor alpha. *Environ. Toxicol. Chem.* 29(9): 2064-2071.

**Abstract:** Reproductive abnormalities in alligators exposed to contaminants in Lake Apopka, Florida, USA, represent a clear example of endocrine disruption in wildlife. Several of these contaminants that are not able to bind to mammalian estrogen receptors (such as atrazine and cyanazine) have previously been reported to bind to the alligator estrogen receptor from oviductal tissue. Binding of known Lake Apopka contaminants to full length estrogen receptors alpha from human (hERalpha) and alligator (aERalpha) was assessed in a side-by-side comparison within the same assay system. Baculovirus-expressed recombinant hERalpha and aERalpha were used in a competitive binding assay. Atrazine and cyanazine were not able to bind to either receptor. p,p'-Dicofol was able to bind to aERalpha with a concentration inhibiting 50% of binding (IC50) of 4 microM, while only partially displacing 17beta-estradiol (E2) from hERalpha and yielding a projected IC50 of 45 microM. Chemicals that only partially displaced E2 from either receptor, including some dichlorodiphenyltrichloroethane (DDT) metabolites and trans-nonachlor, appeared to have higher affinity for aERalpha than hERalpha. p,p'-Dicofol-mediated transcriptional activation through aERalpha and hERalpha was assessed to further explore the preferential binding of p,p'-dicofol to aERalpha over hERalpha. p,p'-Dicofol was able to stimulate transcriptional activation in a similar manner with both receptors. However, the *in vitro* results obtained with p,p'-dicofol were not reflected in an *in vivo* mammalian model, where Kelthane (mixed o,p'- and p,p'-dicofol isomers) did not elicit estrogenic effects. In conclusion, although there was no evidence of exclusively species-specific estrogen receptor binders, some xenoestrogens, especially p,p'-dicofol, had a higher affinity for aERalpha than for hERalpha.

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WANG, L. and Wu, X. (2010). Research on major problems in conservation of Chinese alligator *sinensis* and management strategies. *Journal of Fuyang Teachers College*.

**Abstract:** Based on the investigation about the conservation status of wild and breeding populations of alligator *sinensis*, our research put forward major problems about the current conservation of Chinese alligator: Including severe habitat fragmentation and the defects of the current Nature Reserve Management System; Limited basic facilities and incomplete pedigree information result in significant decrease in fertilization and hatching rate. We also propose some corresponding management strategies: To change the management system of protected areas, restore the existing hilly and wetland-type habitats and to build the sheet-type of

wetland habitats for alligator *sinensis*; to increase the investment to the breeding and research center in Xuancheng, accelerate to complete the pedigree information, launch PVA (population viability analysis) and evaluate the effective population of each breeding population.

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McBride, R. and McBride, C. (2010). Predation of a large alligator by a Florida panther. *Southeastern Naturalist* 9(4): 854-856.

**Abstract:** *Alligator mississippiensis* (American Alligator), ranging in size from 45.7-152.4 cm, have been identified as a *Puma concolor coryi* (Florida Panther) prey species. On 14 March 2008, we discovered a 269.2 cm alligator that was killed and fed upon by a male panther; this record is the largest one reported to date

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Brandt, L.A., Campbell, M.R. and Mazzotti, F.J. (2010). Spatial distribution of alligator holes in the central Everglades. *Southeastern Naturalist* 9(3): 487-496.

**Abstract:** Alligator holes are a key feature of Everglades marshes that provide refugia and foraging sites for a wide range of species. We investigated the spatial pattern of alligator holes in Water Conservation Area 3, a part of the central Everglades, and examined associations among alligator holes, canals, and hydrology. There were fewer alligator holes within 1000 m of canals than expected, supporting the hypothesis that *Alligator mississippiensis* (American Alligator) are using canals as aquatic refugia rather than creating or maintaining alligator holes in the marsh. In addition, density of holes was associated with hydrology; specifically, areas that were drier had more than twice as many alligator holes than areas that were wetter. Analyses from this study provide a baseline for evaluating changes in location and density of alligator holes in response to canal removal and hydrologic changes that will occur as part of Everglades restoration.

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Feuer, B. and Domash-Martinez, T. (2011). Report of case: leptospirosis after exposure to alligator carcass. *Osteopathic Family Physician* 3(1): 23-26.

**Abstract:** In the past decade, leptospirosis has emerged as a globally important infectious disease. Mortality remains significant; this may be related to delays in diagnosis because of lack of infrastructure and adequate clinical suspicion, and to other poorly understood reasons that may include inherent pathogenicity of some leptospiral strains or genetically determined host immunopathological responses. Leptospirosis is a spirochete parasitic bacterium most commonly reported from rodents and contracted through contact with rodent urine, but also reported from cows and other domestic animals and contracted through contact with contaminated water. Humans are infected by direct contact with animals or through exposure to fresh water or soil contaminated by infected animal urine. Leptospire enter the body through cuts and abrasions, mucous membranes or conjunctivae, or



aerosol inhalation of microscopic droplets. From 1995-1998, approximately nine people working with alligators in south Florida have apparently contracted leptospirosis. All of the victims were working with wild alligators; most had contact with alligator nests and nearly half required hospitalization. Although it has been postulated that leptospire may be transmitted directly from infected, large reptiles to the hands of handlers, it has been felt that it was probably more likely that handlers were indirectly exposed by water contaminated with the urine of leptospiruric reptiles or that the swamps and waterways from which eggs are harvested are contaminated by the infected urine of rodents or other animals. This report describes a case in which a Florida State Trooper became symptomatic after removal of an alligator carcass from a south Florida roadway.

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Merchant, M., Guinna, P., Rydera, F., Merrill, J. and Deumitea, J. (2010). Measurement of alligator (*Alligator mississippiensis*) serum angiotensin converting enzyme (ACE) using a miniaturized colorimetric assay. *Microchemical Journal* 96 (2): 371-373.

**Abstract:** Oftentimes enzyme assays can be difficult when utilizing tissues from rare, endangered or exotic animals due to limited tissue supplies. We have miniaturized a common assay for angiotensin converting enzyme (ACE) to a microtiter plate format. The assay is based on the reduction of the optical density at 340 nm when the substrate 2-furanacryloyl-L-phenylalanyl-glycylglycine (FAPGG) is enzymatically-converted to the product 2-furanacryloyl-L-phenylalanine (FAP). The assay was used to measure ACE activity in alligator serum. The optimal pH for this assay was 7, while the ionic strength-dependence was optimal at 25–50 mM NaCl. ACE enzyme activity requires zinc, and thus the assay was sensitive to the presence of EDTA. Inclusion of only 0.2 mM EDTA-inhibited ACE activity by more than 70%. The assay only required the use of only 10  $\mu$ L of sample for measurable activity, and maximal activity was recorded using 60–65  $\mu$ L of serum, making it ideal for use with small amounts of blood or tissue extract.

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Boonyang, U., Chaopanich, P., Wongchaisuwat, A., Senthongkaew, P. and Siripaisarnpipat, S. (2010). Effect of phosphate precursor on the production of hydroxyapatite from crocodile eggshell. *Journal of Biomimetics, Biomaterials and Tissue Engineering* 5: 31-37.

**Abstract:** The hydrothermal reaction at 250°C between crocodile eggshells and three phosphate precursors,  $(\text{NH}_4)_2\text{HPO}_4$ ,  $\text{Ca}_3(\text{PO}_4)_2$  and  $\text{H}_3\text{PO}_4$  were studied. Only  $(\text{NH}_4)_2\text{HPO}_4$  and  $\text{Ca}_3(\text{PO}_4)_2$  precursors gave monophasic hydroxyapatite within 25 and 8 h, respectively. Pure hydroxyapatite could not be produced when using  $\text{H}_3\text{PO}_4$ . The characteristic vibration for  $\text{PO}_4^{3-}$  are observed at 566-603, 1043-1093, 962-963 and 466-474  $\text{cm}^{-1}$  and for OH- group at 3570-3572 and 633-634  $\text{cm}^{-1}$ . The morphology of the prepared hydroxyapatite is agglomerated plate-like crystals. The Ca/P ratio by ICP method is 1.62-1.64.

Ashton, P. (2010). The demise of the Nile crocodile (*Crocodylus niloticus*) as a keystone species for aquatic ecosystem conservation in South Africa: The case of the Olifants River. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20(5): 489-493.

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Brooks, S.E., Allison, E.H., Gilla, J.A. and Reynolds, J.D. (2010). Snake prices and crocodile appetites: aquatic wildlife supply and demand on Tonle Sap Lake, Cambodia. *Biological Conservation* 143(9): 2127-2135.

**Abstract:** Commercial trade is a major driver of over-exploitation of wild species, but the pattern of demand and how it responds to changes in supply is poorly understood. Here we explore the markets for snakes from Tonle Sap Lake in Cambodia to evaluate future exploitation scenarios, identify entry points for conservation and, more generally, to illustrate the value of multi-scale analysis of markets to traded wildlife conservation. In Cambodia, the largest driver of snake exploitation is the domestic trade in snakes as crocodile food. We estimate that farmed crocodiles consume between 2.7 and 12.2 million snakes per year. The market price for crocodiles has been in decline since 2003, which, combined with rising prices for their food, has led to a reduced frequency of feeding and closure of small farms. The large farms that generate a disproportionate amount of the demand for snakes continue to operate in anticipation of future market opportunities, and preferences for snakes could help maintain demand if market prices for crocodiles rise to pre 2003 levels. In the absence of a sustained demand from crocodile farms, it is also possible that alternative markets will develop, such as one for human snack food. The demand for snakes, however, also depends on the availability of substitute resources, principally fish. The substitutability and low price elasticity of demand offers a relatively sustainable form of consumerism. Given the nature of these market drivers, addressing consumer preferences and limiting the protection of snakes to their breeding season are likely to be the most effective tools for conservation. This study highlights the importance of understanding the structure of markets and the behaviour of consumer demand prior to implementing regulations on wildlife hunting and trade.

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### **Submitted Articles**

PHYTOTHERAPY FOR CROCODILIANS. Over several years the Crocodile Museum has applied various medicinal herbs to treat captive crocodilians, and have achieved significant results. These remedies do not require capture and/or restraint of the animal as is the case for the application of chemical agents, and involve natural products that are environmentally-friendly.

Of more than 3000 species of medicinal plants known, we experimented with only 11 with crocodilians. Combinations of different plants have now been used to treat more than 200 crocodilians representing the three Mexican species (*Crocodylus moreletii*, *C. acutus*, *Caiman crocodilus*).

Generally, we feel that the health of animals has been restored in cases where the use of drugs was not possible (eg anorexia, blood parasites, paralysis, digestive problems, eye infections, etc.). Some herbal “teas” have also been applied to other species of reptile and amphibian with effective results.

The 11 plants used for crocodilians are listed below (A-K), together with the medical conditions for which they are considered beneficial.

- A. **Chamomile** (*Matricaria chamomilla*): Digestive system, gastric ulcers, poor appetite. Internal and external wounds. Poor digestion, constipation, stomach pain.
- B. **Rough Horsetail** (*Equisetum hyemale*): Digestive system, gastric ulcers, poor appetite. Internal and external wounds. Inflammation or kidney problems.
- C. **Mexican Poppy** (*Argemone mexicana*): Digestive system, gastric ulcers, poor appetite. Inflammation or kidney problems. Poor digestion, constipation, stomach pain.
- D. **Garden Cress** (*Lepidium sativum*): Digestive system, gastric ulcers, poor appetite. Poor digestion, constipation, stomach pain.
- E. **Arnica** (*Heterotheca inuloides*): Digestive system, gastric ulcers, poor appetite. Internal and external wounds.
- F. **Cuachalalate** (*Amphipteryngium adstringens*): Digestive system, gastric ulcers, poor appetite.
- G. **Yellow Trumpetbush** (*Tecoma stans*): Digestive system, gastric ulcers, poor appetite.

- H. **Gray Sagewort** (*Artemisia ludoviciana*): Digestive system, gastric ulcers, poor appetite. Poor digestion, constipation, stomach pain.
- I. **Garlic** (*Allium sativum*): Parasite (worms), tapeworms, amoebae. Circulatory system, varicose veins, hemorrhoids, arthritis, uric acid.
- J. **Chaparro Amargo** (*Castela texana*): Parasite (worms), tapeworms, amoebae.
- K. **Marigold** (*Calendula officinalis*): Internal and external wounds.

Preparation of “teas” are similar. Based on the final volume of water in which the crocodile is housed, the desired amounts of each ingredient were added to water, and the solution boiled for 30-60 minutes. After the tea was allowed to stand for 60 minutes, it was applied to the pond. Where possible or appropriate, the tea was poured through a hose, the other end of which was placed near/in the mouth of the crocodile being treated.

The use of herbal remedies in crocodiles has proved an effective procedure to maintain a better quality of life for individuals in captivity, to avoid invasive procedures, and ensuring a strong recovery of the immune system. The acquisition of plants and preparation is economical compared to the use of drugs, the waste solutions are biodegradable and not detrimental to the environment, and they can be used as prophylaxis without side effects.

#### Acknowledgments

Liliana Berenice García-Reyes (translation).

Table 1. Amounts of each plant species (A-K) required to prepare “teas” for different conditions in crocodilians. A= chamomile, B= rough horsetail, C= Mexican poppy, D= garden cress, E= arnica, F= cuachalalate, G= yellow trumpetbush, H= gray sagewort, I= garlic, J= chaparro amargo, K= marigold.

Condition	Plants	Amount of each plant species per 100 litres of pond water	Frequency of Application
Prophylaxis	A+B+J+K	1.25 g of each	Leave for 3 days. Repeat every 15 days.
Deworming	A+I+J	5.0 g of each	Leave for 2 days, reapply after another 2 days; Repeat after 15 days.
Minor injuries	A+E	2.5 g of each	Leave for 5 days, repeat after one week.
Serious injuries	A+B+E+K	7.5 g of each	Leave for 5 days, repeat treatment twice again.
Anorexia	A+B+C+D+E+F+G+H	2.64 g of each	Leave for one week; repeat weekly for 2 months.
Digestion	A+C+D+H	2.5 g of each	Leave for one week; repeat weekly for 2 months.
Liver Guard	B+C	5.0 g of each	Leave for 5 days. Repeat every 2 weeks for 3 months.
Hemoparasites	B+C+I+J	7.5 g of each	Leave for 2 days, reapply after another 2 days; Repeat after 15 days.

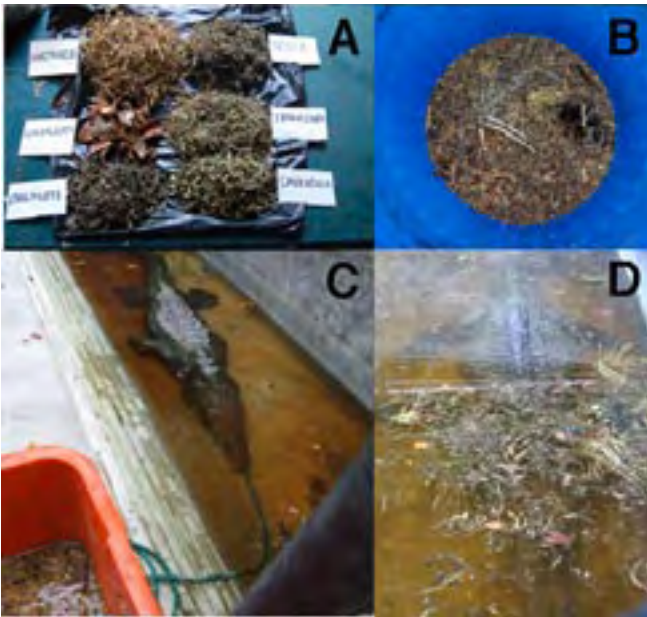


Figure 1. A. Some plant ingredients; B. Mixture of plants (“tea”) prepared for boiling; C. “Tea” being administered through a plastic tube placed near/in an anorexic crocodile’s mouth; D. Remaining “tea” placed into the anorexic crocodile’s (submerged) enclosure.

Jerónimo Domínguez-Laso, *Curator of Crocodile Museum - Secretaría del Medio Ambiente, Vivienda e Historia Natural - Regional Zoo “Miguel Álvarez del Toro”, Tuxtla Gutiérrez, Chiapas, México - COMAFFAS/Línea Crocodylia <museococodrilo@yahoo.com.mx>*, Jorge Domínguez de Anda and Ma. Teresa Laso Roa, *Casa de los Abuelos, Centro de Armonía, San Juan del Río, Querétaro <don\_jor@hotmail.com>*.

ZOER (2010) *OSTEOLAEMUS SEPTUM CORRECTION*. We wish to correct an accidental error on page 47 in Zoer (2010). In the assertion “There is a difference in nasal septa (dividing the nasal chamber in two) between *Osteolaemus t. tetraspis* and *Osteolaemus t. osborni* (respectively the absence and presence of a septum)”, something got reversed, because in *O. tetraspis* (Cope 1861), the complete bony septum is present, while in *Osteoblepharon osborni* (Schmidt 1919), the internarial partition separating the left external nostril from the right is incompletely ossified.

“*Osteolaemus*, Cope, was characterized as a genus of Crocodiles presenting several points of analogy to the Alligators. The nasal bones were prolonged anteriorly, and uniting with the short spine of the intermaxillary [today the premaxillary bones], divided the external nasal orifice, as in the genus *Alligator*.” (Cope 1861).

“*Osteoblepharon*, new genus. Nasal bones entering the nasal aperture, not produced as a bony nasal septum.” [not uniting with a short premaxillary spine] (Schmidt 1919).

As far as we know, all crocodylians have an internarial septum, but it is mostly cartilage in many taxa. It is normal in *Crocodylus* to have the anterior tips of the nasal bones entering the external narial orifice, and also to have a short posteriorly directed projection of premaxillary bone entering the external nose hole of the skull. Thus, *Osteoblepharon osborni* resembled the *Crocodylus* condition of having a mostly cartilage septum, while in *O. tetraspis* the basic crocodylian septum is completely ossified, and the nasal bone projection contacts the premaxillary projection without any unossified cartilage separating them from each other.

It appears from the completely ossified septums in *Alligator mississippiensis* and *A. sinensis* and in *O. t. tetraspis* (as opposed to *O. t. osborni*), that the cartilage in the *Crocodylus* septum is derived mostly from the prolongation of the nasal bones, and the contribution from the premaxillary bones is considerably less, though distinct. This strongly suggests that the septum itself is not an independent ossification.

Some African dwarf crocodile skulls have the completely bony septum (illustrated for *O. tetraspis* by Schmidt), while some have a pretty much unossified septum (illustrated for *O. osborni* by Schmidt), but we note that the fundamental nature of cartilage replacement bone suggests that an intermediate condition must exist. There should be circumstances, including embryos and ontogenetic variation, where an almost completely bony, but not actually completely ossified septum is encountered. Has anyone seen a crocodylian with a half cartilage and half bone division between its external nostrils?

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- Franklin D. Ross, *NCB Naturalis, box 9517, Leiden 2300RA, the Netherlands* and Roland P. Zoer, *Turfring 30, Tolbert 9356HB, the Netherlands*.

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**Regional Chairmen, Europe:** Dr. Jon Hutton, UNEP World Conservation Monitoring Centre, United Nations Environment Program, 219 Huntingdon Road, Cambridge CB3 0DL, UK, Tel: (44) 1223 277314, Fax: (44) 1223 277136, <Jon.Hutton@unep-wcmc.org>; Samuel Martin, La Ferme aux Crocodiles, Pierrelatte, France, <s.martin@lafermeauxcrocodiles.com>. **Regional Vice Chairman:** Ralf Sommerlad <crocodilians@web.de>.

**Regional Chairmen, North America:** Dr. Ruth Elsey, Louisiana Wildlife and Fisheries Department, 5476 Grand Chenier Highway, Grand Chenier, LA 70643, USA, Tel: (1) 337 5382165, Fax: (1) 337 4912595, <relsey@wlf.louisiana.gov>; Allan Woodward, Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, FL 32601, USA, Tel: (1) 352 9552081, Fax: (1) 352 9552183, <allan.woodward@myfwc.com>. **Regional Vice Chairmen:** Noel Kinler <nkinler@wlf.louisiana.gov>; Harry Dutton <harry.dutton@myfwc.com>.

**Vice Chairman for IUCN:** Dr. Perran Ross, Department of Wildlife Ecology and Conservation, P.O. Box 110430, University of Florida, Gainesville, FL 32611, USA, Tel: (1) 352 392 7137, <pross@ufl.edu>.

**Vice Chairman for CITES:** Hank Jenkins, P.O. Box 390, Belconnen, ACT 2616, Australia, Tel: (61) 2 62583428, Fax: (61) 2 62598757, <hank.jenkins@consol.net.au>; **Deputy Vice Chairman:** Dr. Yoshio Kaneko <gtrust@wa2.so-net.ne.jp>.

**Vice Chairman, Industry:** Don Ashley, Belfast Dr., Tallahassee, FL 32317, USA, Tel: (1) 850 893 6869, <Jdalligator@aol.com>.

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**Vice Chairman, Trade Monitoring:** John Caldwell <john.caldwell@mad.scientist.com>. **Deputy Vice Chairman:** James MacGregor <James.MacGregor@WorleyParsons.com>; Steve Broad, TRAFFIC International <steven.broad@traffic.org>.

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**Vice Chairman, Zoos and Community Education:** Dr. Kent Vliet, University of Florida, Gainesville, FL 32611, USA, Tel: (1) 352 3928130, Fax: (1) 352 3924738, <kvliet@ufl.edu>.

**Vice Chairman, General Research:** Dr. Valentine Lance, Graduate School of Public Health, San Diego State University, San Diego, CA, USA, <lvalenti@sunstroke.sdsu.edu>.

**Vice Chairman, Legal Affairs:** Tomme Young <tomme.young@googlemail.com>.

**CSG Red List Authority:** Dr. Perran Ross, Department of Wildlife Ecology and Conservation, P.O. Box 110430, University of Florida, Gainesville, FL 32611, USA, Tel: (1) 352 392 7137, <pross@ufl.edu>.

**Honorary Steering Committee Members:** Prof. Harry Messel (Australia), Ted Joanan (USA), Romulus Whitaker (India), Phil Wilkinson (USA), Prof. F. Wayne King (USA), Dr. Fritz Huchzermeyer (South Africa).

**Task Force/Working Group Chairmen:** Chinese Alligator, Dr. Jiang Hongxing <hxjiang@forestry.ac.cn>; Tomistoma, Bruce Shwedick <Bshwedick@aol.com>; Human-Crocodile Conflict, Dr. Richard Fergusson <fergusson@mailweb.co.za>.