CROCODILE SPECIALIST GROUP NEWSLETTER

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COVER PHOTOGRAPH: Cuvier's Dwarf Caiman, *Paleosuchus palpebrosus*. Photograph: Andres Pacheco.

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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

As all CSG members are aware, on 22 June 2010 we learnt that Jack Cox had died in Laos, apparently from cerebral malaria. The year 2010 is proving to be the worst ever for the CSG! Jack was a tireless and dedicated worker who "found crocodiles" in Papua New Guinea in the early 1980s, and continued to work on them ever since, particularly in the Asian region. He championed crocodile management in Indonesia in the late 1980s and early 1990s, was the first person to report that there really was a population of *C. siamensis* in Kalimantan, and worked in numerous other countries on various projects. People with Jack's knowledge and unique experience cannot be replaced. It is a truly sad day for the CSG, still recovering from the loss of John Thorbjarnarson earlier in the year. I have extended our sympathies and condolences to Jack's parents.

The loss of JT and Jack have brought into clear focus the need for the CSG and all its members to encourage students to work on crocodiles, so that hopefully some will become future champions for crocodiles and will take the CSG to new heights. The CSG Student Research Assistance Scheme (SRAS) was a great success in 2009, and a further 9 applications have been received in 2010 [Argentina (2), USA (2), Venezuela, Costa Rica, Panama, Ecuador and South Africa (1 each)]. Of these, 7 applications have been approved to date and the remaining two are currently under consideration.

Our thanks to Perran Ross who has agreed to take on the position of CSG Red List Authority. Perran has a long history of dealing with crocodilians on the Red List, and is currently reviewing the updated CSG species assessments, for all crocodilian species, which will be will be transferred to the IUCN's online Species Information Service (SIS). It is important that the CSG contribute to these broader IUCN programs and thus play a role in sustaining the IUCN's international reputation and credibility.

Not so good is that the demand for crocodilian skin products declined greatly with the world recession, resulting in low skin prices, and a serious threats to the viability of some management programs based on sustainable use. Management must always be prepared for risk and uncertainty, but the recession was such a wildcard event that even the best management programs did not have a strategy to counter it. This will clearly be a serious topic on the agenda at the next Working Meeting of the CSG.

The new Secretary-General of CITES is an Australian, John Scanlon, who took up duties on 3 May 2010. John is the fifth CITES Secretary-General, and follows Willem Wijnstekers, who held the post from April 1999 to 30 April 2010. We congratulate John on his appointment and wish Willem all the best for his future, which I'm sure will still be linked to CITES.

I attended the International Workshop on Human-Crocodile Conflict in Kota Kinabalu, Sabah, Malaysia, 23- 25 June 2010, which was sponsored by the Sabah Wildlife Department and co-hosted by the CSG. The results of the meeting were encapsulated into a resolution, unanimously agreed by all participants (see pages 6-7).

As conservation programs work, conflict between people and the increasing numbers of crocodiles mounts. The CSG has received reports of crocodiles being killed in Costa Rica because of conflct, and Deputy Chairman Alejandro Larriera has written to the relevant Government Departments seeking clarification.

Advice was received from the US Fish and Wildlife Service indicating that although the subpopulations of *C. moreletii* in Mexico and Belize were transferred from CITES Appendix I to Appendix II with a zero quota for wild specimens for commercial purposes, such specimens still remain prohibited under the US Endangered Species Act (ESA). The US Fish and Wildlife Service is currently reviewing the conservation status of Morlet's crocodile under the ESA.

The 20th Working Meeting of the CSG will be held at the Studio 5 Convention Center, Manaus, Brazil, 13-16 September 2010, preceded by an Executive meeting on 11th and the Standing Committee meeting on the 12th (page 23). I look forward to seeing you all at the meeting.

The CSG Executive officer sent out annual letters of requests to CSG donors, whose support to the CSG is critical to its ability to operate, particularly in these difficult economic times. I am personally very grateful to everyone who has made a contribution, past and present.

Grahame Webb, *CSG Chairman <gwebb@wmi.com.au>*.

Obituary

Photograph: Chansack Vongkhamheng

Jack H. Cox Jr. (1952-2010)

I first met Jack Cox in 1980 when I was Production Manager for the FAO/UNDP Papua New Guinea Crocodile Project. At that time we were going well on the skin production side of things but still knew woefully little about the biology and status of freshies and salties of PNG. Jack came on board as a UN Volunteer and we assigned him to the Sepik River. Not an easy assignment, he had to patrol the entire 960 km of river in a flat-bottomed aluminium 'John-12' boat, stopping off to spend the night at villages on the way to introduce or check on the status of the new small crocodile buying scheme set up with Government. As if the day travel was not challenging enough, Jack had the job of doing night counts of crocodiles in various lagoons and channels along the river to get a preliminary idea of crocodile status. I will never forget seeing Jack off on one of his month-long patrols, boat running low in the water, Jack sitting comfortably, by himself, next to the outboard, surrounded by the supplies and paraphernalia he would need for the coming 30 days. Now we won't be able to ask him how he avoided logs on the long soporific stretches of the Sepik while deeply engrossed in one of his pile of paperbacks, safely wrapped in a black plastic garbage bag.

I had the early pleasure of introducing Jack to spotlight surveys for crocodiles at Waigani Swamp near Port Moresby, the HQ for the crocodile project. It was eerie going out at night at low water when the wreckage of several Japanese and allied WWII planes was revealed and in fact we even saw a crocodile basking on the tail of one of these downed fighters!

Later Jack he reported to us that *Salvinia*, a noxious South American weed, had completely choked up some of the major barats or waterways leading off from the Sepik - he couldn't access some of the main crocodile areas and villagers were unable to reach some of their hunting and gathering areas by canoe. At this time African crocodile biologist and serious wild man Alistair Graham joined the project, and we zoomed a Panther airboat up the Sepik for Jack to use in these weed-choked channels, an exhilarating 'first' for PNG. Years later, when Jack was back as a consultant, seriously pushing the idea of protecting nesting female crocodiles and sustainably harvesting the eggs, there was one recalcitrant crocodile hunter who just wouldn't listen to Jack's good advice and set nets for females whenever he found a nest. Well, that man just happened to fall out of his boat one day and got chopped by his own motor as it circled around; the local people all felt that it was because he had displeased Jack and gone against the project's good sense! Similarly, when Jack survived almost unscathed, falling down a cliff and going through the roof of a house in an astounding jeep accident in Jayapura, there was a lot of very awed gossip around town about how Jack was protected and better be listened to!

Nine years later, Jack wrote (with a simple return address of 'Jack Crox', FAO, Jayapura) inviting me to come over to the other side of New Guinea, the magical Irian Jaya (now Papua Province), where he headed a very similar crocodile project. On his office wall in Jayapura was his calendar, marked all over in Nepali script. When I asked him about it he said that anything he wanted to keep confidential he just wrote in Nepali! I went with Jack on patrol and surveys and village extension work to remote and wonderful parts of the country and produced a training manual in Bahasa Indonesia (in which Jack was fluent) to help villagers start their own crocodile holding pens. We came across people who were being paid the equivalent of $15 to fell a huge hardwood tree on the river to be taken down river and sold abroad for huge profits. One of Jack's project goals was to establish a crocodile buying network to bring fair prices to the villagers: they were being so ripped off by traders and they could make as much selling a small crocodile as they could from destroying a huge tree!

Considering the difficulties of working in Irian Jaya (not only the physical logistics, but the officialdom which was energy-draining), Jack was one tough nut and managed to accomplish wonders by being a balance of a meticulous biologist, a canny planner and a very understanding person when it came to the woes of the villagers. On one patrol to a village called Pagai, we found that the village had been burned to the ground by Indonesian soldiers, suspecting that OPM (freedom movement) rebels lived there. Jack helped nurse these people back to some level of confidence by bringing them into the crocodile project, helping to rebuild their village and their lives.

Besides doing surveys and planning conservation projects Jack spent a lot of time trekking in Nepal. His three bases, outside of Charlotte (North Carolina, USA) were Kathmandu, Bangkok and Bali, where he narrowly missed both "terrorist" bombings: "Just thought I'd drop ya'll a line letting you know I'm fine. When the Kuta Plaza bomb exploded last night I was about 300 metres away on the beach waiting for photos to be printed at nearby Fuji Pantai."

Jack was also pretty stubborn and could drive you nuts with his self assurance and persistence about his point of view being the right one. He worked with documentary film makers in PNG, Kalimantan (where he also did crocodile work) and Sulawesi, and in the late 1990s he worked on a nature

reserve assessment on Flores. Around that time he surveyed crocodiles in Bangladesh and was meanwhile helping to develop landscape conservation initiatives in Nepal, far above crocodile territory.

Photograph: Rom Whitaker

This dude was a real world citizen, expressing the philosophy that comes naturally to naturalists: no countries, no boundaries, just habitats and the creatures and people that live in and use them. This statement of his bears witness: "North Carolina will always be home, but PNG, Nepal and Indonesia have become part of who I am, and maybe going forward, Laos and Thailand will also do that to me."

For all his dedication to taking on tough (invariably exciting) jobs, Jack knew how to unwind and relax. He used the high mountains of Nepal to ease his mind and "recharge my batteries" (though how the hell you recharge with all that strenuous trekking, I don't know!).

He was hit hard when Tirtha Maskey was killed in 2006: "As some or most of you may already know, yesterday a Shree Airlines MI-172 helicopter with 24 passengers on board crashed about 5 minutes after takeoff from Gunsa in far eastern Nepal. Of ineffable disbelief is that the former Director General of DNPWC, Dr. Tirtha Maskey was also onboard the ill-fated flight. He has been a good friend and colleague for more than 25 years. I don't know what to say except that I'm sure Dr. Maskey would want us to continue to pursue his conservation initiatives."

Jack was a dear friend to many and an intrepid field man. He had a mostly quiet, observant, patient presence and inspired confidence, which translated into many a trained field person in his favourite countries. He was so very interested in everything natural, and had a deep soft spot for who I call the 'real' people: the swamp, river, mountain and forest people of New Guinea and Asia, who live in and amongst nature, always beautiful, sometimes dangerous. Losing a good buddy like Jack is a hard blow for all of us and for crocodile conservation. There is a large bunch of people scattered in odd places around the world recalling truly enjoyable times with Jack in the field or over a beer. The kind of work Jack was so passionately involved in is usually done under somewhat trying conditions (boat motors break down, food runs out, it's hot and humid beyond belief, the mozzies are hell and the bureaucrats are worse), but unfazed by all this, Jack was invariably upbeat and positive even when the road was mighty bumpy!

Photograph: Bruce Shwedick.

And then another severe blow in February this year: "I'm absolutely devastated by the news of John T's death. I'd just emailed him the other day and was looking forward to talking with him from India. John's wide-ranging, prolific and extremely dedicated work the world over with crocodile conservation is an immense and amazing contribution to the CSG and global conservation. A great career cut short. We

should have had the benefit of many more years of John's expertise, wisdom, helpfulness and keeness for complex challenges that he so calmly took on. Having had bouts of malaria through the years, mainly contracted from PNG, and including cerebral malaria, it is scary to try and comprehend how John, a picture of apparently fine health, is with us no more." *(And herein lies a strong message to all you crocodile people, at risk just because of their chosen work).

Most recently, Jack had been working as a consultant for the Wildlife Conservation Society as technical advisor on a community-based Siamese crocodile recovery project in southern Laos. In early June this year he was as always, bursting with plans.

Rom Whitaker, <serpentcatcher@yahoo.com>

International Workshop on Human-Crocodile Conflict

The theme of the International Workshop on Human-Crocodile Conflict (Kota Kinabalu, Malaysis, 23-25 June 2010) was "Crocodile Conservation through Sustainable Use". Some 75 participants from five countries (Malaysia (Sabah, Sarawak), Brunei, Philippines, Australia and Japan, attended.

Participants were welcomed by Dr. Laurentius Nayan Ambu, Director of the Sabah Wildlife Department, and the opening address was given by Yg. Berhormat Datuk Masidi Manjun, Minister of Tourism, Culture and Environment Sabah, followed by a special dance performance by local indigenous dancers. A keynote address on "The significance of HCC in crocodile conservation and management" was presented by Professor Grahame Webb (CSG Chairman).

The conservation of *Crocodylus porosus* throughout its range was addressed in presentations by Mr. Matthew Brien (Australia), Dr. Glen Rebong (Philippines) and Ms. Siti Northayatty Binti Haji Marn (Brunei). Unfortunately Dr. Richard Fergusson (Africa) was unable to attend, buthis presentation was given on his behalf by Prof. Webb.

Specific crocodile conservation issues in Malaysia were addressed in presentations by Mr. Wilfred Landong (Sarawak), Mr. Augustine Tuuga (Sabah), Assoc. Prof. Dr. Hamid Ahmad (University of Malaysia Sabah) and the Sandakan Crocodile Farm Sdn. Bhd.

On the afternoon of the second day, participants divided into four Working Groups to consider: 1. Monitoring; 2. Sustainable use; 3. Public education and awareness; and, 4. Land use planning to ease Human-Crocodile Conflict. Following presentation and discussion of the recommendations of each Working Group, participants unanimously endorsed the following Resolution.

ACKNOWLEDGING that crocodiles are an integral part of the biodiversity of Sabah, Sarawak and Brunei with important cultural, biological and economic significance.

RECOGNIZING the success of crocodile conservation efforts in Sabah, Sarawak and Brunei as evidence by the results of scientific monitoring programs confirming the size of the wild populations are increasing, sometime greatly.

AWARE that expanding populations of crocodiles are resulting in increased attacks on people which threatens public support for on-going crocodile conservation efforts.

ACCEPTING widespread public support for crocodile conservation will be difficult to sustain unless the benefits of having large and secure wild populations outweigh the costs of having to live with those large populations.

NOTING that crocodile farming is a viable industry in Sabah and Sarawak, with scope for expansion if strictly controlled sustainable use programs for wild eggs, juveniles and problem animals are implemented in the future.

Participants in the International Workshop on Human-Crocodile Conflict (HCC) held in Kota Kinabalu, Sabah 23-25 June 2010 and sponsored by Sabah Wildlife Department with assistance from IUCN-SSC Crocodile Specialist Group unanimously agreed:

1. To congratulate governments of Sabah, Sarawak and Brunei for implementing management actions, mainly protection, that have allowed severely depleted wild populations of Saltwater crocodiles to recover and thereby avoid the threat of extinction.

2. That the management programs are needed to sustain the increased wild populations in Sabah, Sarawak and Brunei will need to be more diverse and better tailored to the values people can and do attribute the crocodiles.

3. That some of the important issues that need to be considered in formulating new management prescriptions are:

   A. Monitoring

   Develop and integrate monitoring programs, using standardized survey methodologies, to answer specific management questions.

   Identify significant habitats for example nesting areas.

   Compile HCC databases and assess likely cause and effects relationships with the crocodile population and human activity data.

   Ensure core funding from governments is available for long term monitoring and management obligations while encouraging increased involvement by the private sector where appropriate.

   B. Sustainable Use

   Establish working group comprising communities, wildlife managers, scientists, tourism players, farmers

and traders to draft management strategies and programs in Sabah, Sarawak and Brunei.

Ensure incentive driven conservation mechanisms are the foundation of the Crocodile Management Program in Sabah, Sarawak and Brunei.

Incorporate procedures for dealing with problem crocodiles in the management programs to reduce the probability of attacks on people.

Work toward down-listing of *C. porosus* in north Borneo to CITES Appendix II in coordination and collaboration with Sabah, Sarawak and Brunei.

C. Public education and awareness

Examine the possibility of appointing local people as honorary wardens to educate communities living in areas where crocodile reside.
Develop signage and posters where appropriate in areas that contain crocodiles to warn people of risks.

Seek assistance from local NGOs, other associations and government departments to help educate adults and children about crocodiles and public safety.

Develop specific education packages for primary, secondary, tertiary students on crocodile awareness emphasizing the value and dangers of crocodiles.

Get the media involved to speak about crocodiles, good and bad aspects, with data and statistics to support them.

Encourage and help crocodile farms to play a more significant role in educating people about crocodiles and promote school visits to crocodile farms for that education purpose.

D. Land Use Planning to Ease Human Crocodile Conflict

Develop guidelines on safe practice in river usage including living quarters/roads/bridges/jetties.

Encourage the design and testing of innovative structures that may help protect people living in communities in crocodile areas e.g. fenced areas or pumps to access water safely.

Reestablish and maintain riparian reserves that may be extended to include specific crocodile nesting habitats, as buffer zones, particularly adjacent to deep water.

Examine the degree to which pollution is reducing available food for large crocodiles and thus may be inadvertently increasing the frequency of crocodile attacks on people.

4. To hold a further HCC meeting, perhaps in Sarawak or Brunei, in or around May-June 2011, to assess the progress been made with crocodile management in Sabah, Sarawak and Brunei, and to refine any proposals been prepared to down-list Saltwater crocodiles to Appendix II of CITES.

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

Student Research Assistance Scheme Update

Up until June 2010, 9 applications for SRAS funding had been received (Argentina 2, Costa Rica 1, Ecuador 1, Panama 1, South Africa 1, USA 2, Venezuela 1), of which three have been approved to date (see below). Projects approved in 2009 can be viewed at: http://www.iucncsg.org/ph1/modules/Grants/srasprojects.html.

- Junior Telesforo larreal (Universidad Del Zulia, Venezuela): Conservation of American crocodile (*Crocodylus acutus*) with participation of indigenous Bari in the Maracaibo Basin, Venezuela.
- Andres Jimenez Solera (Uni of Estatal Distancia, Costa Rica): Population structure of *Crocodylus acutus* in wetlands of the lower Tempisque River basin, Guanacaste, Costa Rica.
- Joseph Lewis (Texas A&M University, USA): Population ecology and habitat selection of and inland alligator population at the edge of the distribution range.

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

Historical Photograph

The following letter was received by the CSG Executive Officer on 5 June 2010.

Greetings from Lima, Perú,

I'm sending this old picture of a *C. acutus* for the Newsletter. Somehow, I can't stop thinking John [*Thorbjarnarson*] would have loved to see it. I told him many stories of this crocodile which had been caught in the Chira River many years ago and was kept (dissected) at the local school. Unfortunately I didn't have any pictures of the croc to show him, so he always made fun of me for not having any proof of it.
So for quite a while now I had been asking a friend of mine who lives in Sullana (the town the Chira River runs through) to take a picture of the crocodile. Just today, he sent me this old picture he found while visiting the priests at the local school where he studied and where the specimen itself is kept as part of the school's museum collection.

The Chira River, in the Department of Piura, Perú, was the southern limit of the crocodile's range historically and this is where this crocodile was captured and killed in 1975 approximately. In the picture we can see Father Gino Grossi (who dissected the specimen) and his students at Saint Rose School in Sullana. We don't know who took the picture but it was sent to me by my friend and colleague Alejandro Zegarra Pezo who works with tapirs in northeastern Perú. And that's

how the story goes! Thanks.

Ana Maria Trelancia (Lima, Perú)

Regional Reports

South Asia and Iran

Iran

LATE HATCHING OR LOW GROWTH RATE? The nesting season for Mugger crocodiles (*Crocodylus palustris*) in Iran has been reported to be May, and consequently the eggs hatch in July (Mobaraki 1998, 2002). However, it appears that the nesting season could be more prolonged than previously thought. Surveys carried out during the nesting and hatching seasons in 2009 reported the presence of hatchlings on 17 June in Shir Govaz Dam, along the Bahukalat River. This suggests that nesting had taken place in April (Fig. 1). The incubation period for Muggers averages two months in both India and Iran (Whitaker and Whitaker 1984; Mobaraki 2002).

During a winter survey in March 2010, a villager from the Dashtiary area brought a Mugger hatchling to Dargas Station. The animal had been caught in an artificial pond near the village. The hatchling weighed 115 g and was 348.0 mm long (Fig. 2). Mean weight and length of newly hatched Mugger hatchlings in Iran, based on measurements on 10 hatchlings from different nests, were 85.5 g and 299.7 mm respectively (Mobaraki *et al*. 2007).

Assuming that hatching occurred in late July, after 8 months the hatchling is estimated to have gained 48.2 mm (6.0 mm/mth) and 29.5 g (3.7 g/mth). These growth rates are very low for hatchlings in this area [mean growth rate of 5.11 cm/mth has been recorded for two hatchlings, and Whitaker and Whitaker (1984) reported growth rates of 2.8 to 4.25 cm/mth], and may reflect a real reduction in growth rate for this particular animal, or hatching/nesting much later in the year (eg December). In the case of the latter, it is worth noting that multiple nesting in a year has been reported for *C. palustris* in Madras, India (Whitaker and Whitaker 1984). Notwithstanding the lack of data for the species in Iran, this is a possibility to consider, and additional data will be sought to confirm whether multiple nesting occurs in Iran.

The hatchling failed to thrive in captivity, and died in late May due to malnutrition and without any additional growth. It shows no signs of any abnormalities that may have contributed to the low growth rate observed.

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MUGGER CROCODILE HABITAT SUITABILITY STUDY, SARBAZ RIVER, IRAN. Southwestern Iran is the western most limit for the Mugger crocodile (*Crocodylus palustris*). The main habitats for crocodiles are along the main rivers, of which the Sarbaz River is the most important. Local people of the area respect crocodiles and do not directly harme them. The main threats for crocodiles are natural incidents such as floods and drought.

No studies on habitat suitability and classification have been undertaken for *C. palustris* in Iran. Information on habitat characteristics and requirements would provide considerable support to species management and conservation and provide the basis for responses to any deficiencies. We used Habitat Evaluation Procedure (HEP) to define and identify the best and most suitable habitats for Muggers. A Habitat Suitability Index (HSI), a nominal index representing habitat capacity for providing the needs of the species, was used to compare habitats. HSI values range between 0 (worst habitat) and 1 (best habitat).

Ten natural ponds along the Sarbaz River were selected for the study: listed from north to south - Firuz Abad, Shekar Jangal, Azadi, Pishin Dam, Dargas, Lower (Paien) Hutkat, upper (Bala) Hutkat, ShirGoovaz, Bahukalat, Kollani (near Govater Bay) (see Fig. 1). Climatic, physical and chemical characteristics of soil, water and vegetation cover, as well as some ecological characteristics, were collected during monthly surveys over the period September 2008 to January 2010. Information on fauna (fish and amphibians) and flora diversity, water depth, habitat slope and area of ponds and number of crocodiles in habitats was also included.

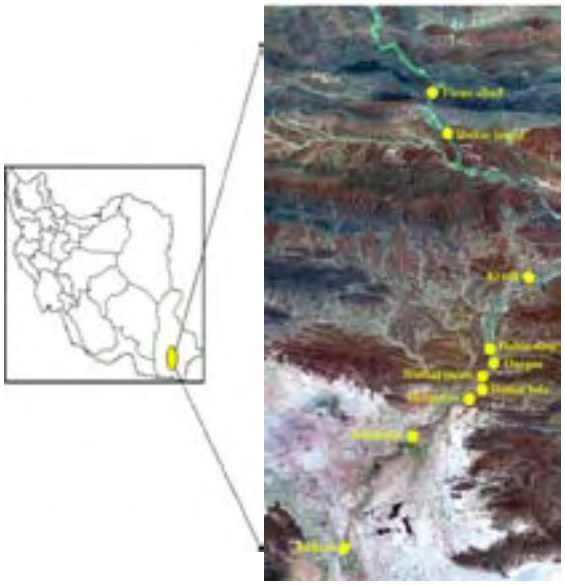

Figure 1. Selected sites/habitats along the Sarbaz River.

The area of the habitat was considered as the initial criterion for selection of study sites, and comprised the highest population density, number of nests and occurrence of juvenile and adult crocodiles. As most sites had thick vegetation, sampling of the number and variety of species was only conducted in 10% of the areas involved. Based on number and variety of species, vegetation diversity was determined using the Ecological Methodology (software) program. Climatic variables (eg temperature, humidity, evaporation, rainfall) were compiled from existing meteorological stations at Bahu-kalat and Sarbaz.

Monthly data were averaged for each parameter, and analyzed using SPSS (correlation between factors). The significant variables were scored using Analytical Hierarchy Process (AHP) and IDRISI KLIMANJARO 8.4 software and the HSI for each habitat calculated. The validity of the results as well as the best function was determined through linear "discriminant function" statistical test. Cluster analysis was used to classify the habitats based on their main characteristics.

There were no significant differences between habitats with respect to variables such as air and soil temperature, humidity, water and soil pH, and soil structure and elements of the habitats. Moreover, correlation test did not show any significant relationship between parameters and crocodile population, with the exception of 6 variables for which significance was recorded (Table 1). Based on AHP, significant parameters were classified into one of three main categories: cover (vegetation cover, depth, slope); food [fish and amphibian species (species richness)]; and, chemical characteristics of water.

Table 1. Pearson Correlation of significant parameters with respect to crocodile population density.

Parameter	Pearson Correlation	P (2-tail)
Water depth	0.739	0.015
Vegetation cover	0.660	0.038
Slope	0.753	0.012
Amphibians	0.864	0.001
Fish	0.674	0.032
Conductivity (water)	0.650	0.042

The highest mean crocodile numbers was observed in Pishin Dam pond (10 crocodiles), and the lowest number (zero) in Kollani and Firuzabad ponds. The HSI for Pishin Dam pond was 1 (highest suitability) (Fig. 2), followed by Shirgovaz, Dargas, Hutkat-e-bala, Hutkat-E-pain respectively (0.96, 0.84, 0.75 and 0.74 respectively). Azadi, Firuzabad and Shekar Jangal had similar HSI (0.3-0.5) and Kollani had the lowest HSI (0.2), indicating that it was the most unsuitable habitat (see Fig. 3).

Figure 2. Pishin Dam Pond is the most important and suitable habitat for *C. palustris* on the Sarbaz River. Photograph: Elham Abtin.

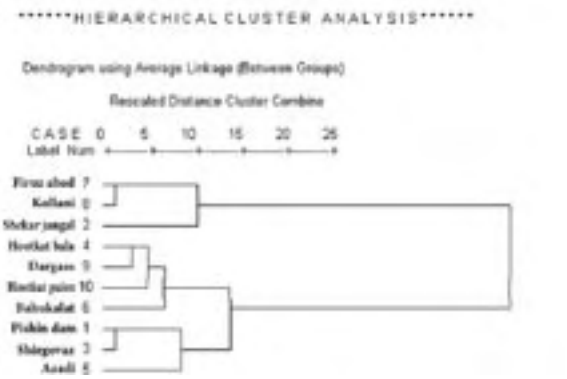

Figure 3. Classification (dendogram) of habitats based on significant parameters.

In general, *C. palustris* prefer habitats with 2-4 m water depth, mean vegetation cover of 35%, mean slope of 25-35% and high species richness of fish and amphibians.

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Europe

Czech Republic

PROTIVIN ZOO TO RECEIVE GHARIAL. The Protivin Zoo is cooperating with India on conservation of Gharial (*Gavialis gangeticus*). Under a new agreement, 7 Gharials from the Madras Crocodile Bank Trust will be imported by Protivin, and 5 Cuban crocodiles (*Crocodylus rhombifer*) will be exported by Protivin to India. The goal of the transfers is to maintain a gene pool of these species in captivity. The Gharial is threatened with habitat loss, and the Cuban crocodile occupies a small area and is threatened by hunting and hybridization with the American crocodile (*C. acutus*).

During a visit to Protivin, two experts from MCBT pledged to send 3 male and 4 female Gharial to the Protivin Zoo and to take 2 male and 3 female Cuban crocodiles to India. Miroslav Prochazka has bred crocodiles since 1996, and Protivin Zoo currently holds 101 crocodiles of 20 species. With the Gharials, the zoo would have 21 of the worlds 23 crocodilian species.

Ralf Sommerlad, *CSG Regional Vice Chairman for Europe, <crocodilians@web.de>.*

France

BUSHMEAT DESTINED FOR EUROPE! In June 2008, Anne-Lise Chaber (Zoological Society of London) spent 2.5 weeks with customs inspectors assigned to flights from sub-Saharan Africa and landing at Paris's Roissy-Charles de Gaulle Airport. She recorded 188 kg of bushmeat and 131 kg of livestock meat (eg sheep) on 29 Air France flights examined. Extrapolation of these data resulted in an estimate of 5500 kg of illegal bushmeat potentially entering France each week. Travellers from Cameroon (69%), Central African Republic (18%) and Republic of Congo (11%) were the main offenders.

The bushmeat is considered to be for sale rather than personal use, fetching $24-30/kg for primate, cane rat, porcupine and crocodile. It often arrived in smoked form, and included Nile crocodile (*Crocodylus niloticus*) and Slender-snouted crocodile (*C. cataphractus*).

Source: *Is that an Alligator in your Suitcase? http://www.newsweek.com (18 June 2010); http://www.africanconservation.org/index.php?option=com_content&view=article&id=1887:is-that-an-alligator-in-your-suitcase&catid=2:conservation-news.*

Latin America and the Caribbean

Peru

BLACK CAIMAN ATTACK ON A HUMAN. As a member of the CSG's Human-Crocodile Conflict Working Group, I had heard very little about Black caiman (*Melanosuchus niger*) attacks on humans. I was aware of anecdotal information about the species being aggressive and trying to get into canoes or biting boats. However, this often sounded more like a strong feeding response and lack of fear, not unlike Cuban crocodiles (*Crocodylus rhombifer*), than it did like an all out attack on a human. Black caiman are large enough to be a threat to humans, but few attacks have been recorded. This could be, in part, due to the fact that Black caiman populations have been severely reduced or even extirpated from many areas due to overhunting. So I took particular note during a trip to western Peru in July 2009, that my guide Hugo Campos had been attacked by a large female Black Caiman.

Hugo is the chief of a Shipibo Indian village (Golondrina), on the Suhuayo canal that is fed by the Ipactia River. The closest town is Contamana, just outside of Pucallpa. Hugo was an excellent guide, showing us all manner of plants and animals as we canoed down the rivers or walked through the forest. Because of my interest in crocodilians, Hugo was excited to help us see "white" caiman (*Caiman crocodilus*) and *M. niger* and to show off his knowledge of their feeding habits and nesting sites. He showed us several large Black caiman nests from the previous season, and when I asked if the species were ever aggressive he recounted the circumstances relating to the attack on him.

Figure 1. Left - Hugo Campos standing next to tree from which he cut bark (top right) to treat wounds caused by *M. niger* attack. Right - healed wound on thigh.

Hugo was alone and raiding Black caiman nests during the 2007 nesting season. He did not notice the 3 m female guarding a nest from which he was about to collect eggs. She sprung from the water and grabbed Hugo on the right thigh. While trying to fight her off she also grabbed him by his right arm. A struggle ensued that Hugo eventually won. When I asked how long he spent in the hospital he gave me a big grin. He took me to a nearby tree with a large scar in the bark, and explained

that he cut the tree, packed his wounds with the antiseptic sap, and made his way back to his village to recuperate (Fig. 1). Hugo reluctantly allowed me to photograph his wounds so that I could document the attack (Fig. 1).

I thank Tim Green of Amazon Adventures (roseate2000@aol.com) who made this trip possible. Tim is a great guide and translator.

John Brueggen, *St. Augustine Alligator Farm Zoological Park, St. Augustine, FL, USA.*

Mexico

MORELET'S CROCODILE IN THE BIOSPHERE PRESERVE OF CENTLA SWAMPS, TABASCO, MEXICO. Morelet's crocodile (*Crocodylus moreletii*) is endemic in the State of Tabasco (Álvarez 1974; Domínguez-Laso 2006; Sigler and Domínguez-Laso 2008). The State is a geographically significant zone for Mexico, with more than one-third of the hydric resources of the country, and wetlands of great importance such as the Biosphere Preserve of Centla Swamps (RBPC). RBPC is one of most extensive wetlands in Mesoamerica, and is classified by RAMSAR as a high priority wetland due to its size (302,706 ha) and biodiversity (Barba *et al*. 2006).

Few studies have been carried out on the distribution and status of *C. moreletii* in Tabasco State. Domínguez-Laso (2006) mentions the possible presence of the species in some regions of the State, including the RBPC and municipalities of Macuspana, Jonuta, Teapa and Tenosique. Remolina (1990) studied the delta zone of the Grijalva-Usumacinta River, and provided an estimate of crocodiles in occupied habitats, and size and sex structure for the population. Significant studies have been undertaken in the Las Ilusiones Lagoon located in the capital of the State (eg Gómez 1995, nesting; Pacheco 1996, effect of human pressure on nest location and estimate of population size), and Figueroa *et al*. (2000a) monitored wild *C. moreletii* populations in the municipalities of Jonuta, Nacajuca and Balancan, with the aim of selecting potential sites for exploitation.

Hernández and Maldonado (2001) developed a proposal for the conservation of *C. moreletii*, noting the importance of sustainability and effective monitoring and marketing strategies for an exploitation program. Domínguez-Laso *et al*. (2004) undertook an evaluation of wild *C. moreletii* populations within the "COPAN Project", whose objective was to analyze demographic information and estimate population parameters such as encounter rate, age classes, sex ratio, status of habitats and overall population status in Mexico. Within this context, quantifying the size of the wild population of crocodiles in the RBPC was considered the first step to evaluate its status and to establish actions for the recovery and exploitation of the species (Figueroa-Ocaña and Cabrera-Aldave 1997).

As part of the Moreletii RBPC Project (Rodríguez-Quevedo *et al*. 2008) a study entitled "Analysis of the Population Structure of *Crocodylus moreletii* in the Eco-tourism Channel Nueva Esperanza in the Biosphere Preserve of Centla Swamps, Tabasco, Mexico" was undertaken between October 2005 and August 2007. The prime objective of this study was to describe the population characteristics of the species in the water body, through information obtained mainly from spotlight counts. This channel is located at 18°23'43.42" N and 92°34'46.18" W, is approximately 8 km long, has an average width of 15 m and an approximate depth of 8 m (Rodríguez-Quevedo 2009).

Survey methodology followed is outlined by Velasco *et al*. (1993, 1997) and Velasco and De Sola (1997), with 4 categories of length (0.23-0.9, 1.00-1.35, 1.40-1.90 and 1.95-3.3 m; Figueroa *et al*. 2000b) being used. Marking of captured animals followed the method described by Bolton (1994). Locations of crocodiles were recorded on a GPS.

We made 49 captures, 2 recaptures and 109 sightings, and located one nest. Length:weight data indicated that most crocodiles were in good health. Sex ratio was skewed towards females. On the basis of size, most females were be considered to be mature or approaching maturity, and most males were considered to be young.

Food availability in the zone is sufficient for crocodiles of different size classes. The proportion of animals sighted that could be captured in part reflects wariness, but it should be noted that the ability to capture animals improved with refinement of capture methods. The impact of anthropogenic factors were not considred significant at this time.

Most crocodiles were in the final half of the channel. This could be because in the other half of the channel is the Community Fishing Cooperative of the Community, and where there is more human activity.

The ability to locate nests was affected by the thick vegetation in the area, and the one nest located was near the main highway - it had been active in the previous season (2007). Eggshells represented around 20 eggs, but this could be an underestimate as there were signs of predation [eg possibly raccoon (*Procyon lotor*), tepezcuintle (*Agouti paca*), badger (*Nasua nasua*), iguana (*Iguana iguana*), domestic dogs (*Canis familiaris*) and domestic cats (*Felis* sp.)].

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Natalia Ovando-Hidalgo *(graduate student)* and Francisco García-Ulloa *(collaborator), División Académica de Ciencias Biológicas de la Universidad Juárez Autónoma de Tabasco. Villahermosa, Tabasco, México.*

TRAINING THE NEXT GENERATION OF MEXICAN CROCODILE HANDLERS. During the many years of contributing to the conservation of Mexican crocodilians, I felt that there were a lot of people involved with research and other work on crocodilians. However, the reality is that there really are not many, and so it is important to encourage young people to become involved with crocodilian conservation, management and research, to take over in the future. With this mind, in 2010 we looked at ways to enhance the training of crocodile handlers through two Workshops on Handling and Conservation of Mexican Crocodylia.

The first workshop took place on 21-23 May at Sanctuary "La Esperanza", near Villaflores Municipality, Chiapas, which has an important population of Morelet's crocodile (*Crocodylus moreletii*) with possible hybrid characteristics of American crocodile (*C. acutus*) (Domínguez-Laso 2010). Thirty participants, representing 7 States of the Mexican Republic, and an international participant from Colombia (Silvana Bustillo Restrepo), were involved in the workshop. We delivered 10 hours of theory and 50 hours of practical, covering topics such as capture methods, survey methodology, marking, blood sampling, extraction of stomach contents, searching for tracks, assembly and installation of traps, and location and handling of nests. The capture of crocodiles longer than 3 m was particularly exciting for participants (Fig. 1).

Figure 1. Participants of training workshop at Sanctuary "La Esperanza", May 2010.

A second workshop took place on 7-13 June in Puerto Vallarta, Jalisco, within the celebration of 10 years of the Reptiliary "Cipactli" of the "Centro Universitario de la Costa" of the University of Guadalajara and the Natural Protected Area (NPA) Estuary "El Salado". Ninety participants, representing 8 States of the Pacific coast with populations of American crocodile (*C. acutus*), were involved. More than 50 hours of practical were involved, including surveys in the NPA "El Salado" and Estuary "Boca Negra" (where on 5 June 2010 a fisherman lost an arm due to crocodile attack), capture and handling methods (some above 3 m long, and within burrows), identification of tracks and burrows, location and handling of nests, safety measures and signage (Fig. 2).

Figure 2. Participants of training workshop at Puerto Vallarta, June 2010.

A further workshop is scheduled to take place in Ixtapa-Zihuatanejo, Guerrero, on 25 August-1 September, where there have been continual interactions between people and crocodiles and where a very important population of *C. acutus* exists (Domínguez-Laso and García-Reyes 2010).

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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>.*

Costa Rica

ANALYSIS OF CROCODILE ATTACKS IN COSTA RICA, 1990-2009. A review of available literature, government and media reports, field interviews, etc., indicated a total of 40 attacks by *Crocodylus acutus* on humans over a 19-year period (1990 to March 2009). A more detailed assessment of these data is now being undertaken, and some preliminary results are presented here.

Although most attacks were not fatal, 11 (27.5%) attacks did result in death of the victim. The majority of attacks occurred in the Pacific region (77.5%), with the Caribbean side contributing 22.5% of attacks. Interestingly, a higher proportion of the attacks on the Caribbean side resulted in fatalities relative to the Pacific coast (55.6% and 19.3% respectively).

Thirty-four of the attacks were considered to be unprovoked, occurring in river (79%), coastal (15%) and lagoon (6%) habitats. Of the 30 attacks where the size of the crocodile was known or could be estimated, all involved *C. acutus* longer than 3.0 m total length: 3-4 m (57%), 4-5 m (30%) and 5-6 m (13%).

The frequency of crocodile attacks is increasing in Costa Rica. An effective education program needs to be developed that conveys relevant information about American crocodiles to communities, to help prevent future attacks.

Luz Denia Barrantes Barrantes, *Crocodilians Specialists Association - Central America (AEC-CA), <aec.costarica@gmail.com, luzdenia@gmail.com>.*

East and Southeast Asia

Philippines

PHILIPPINE CROCODILE RESCUE AND BREEDING PROGRAM. Crocodylus Porosus Philippines, Inc. (CPPI) is happy to announce the initial distribution of funds under its administrative care to the "Philippine Crocodile Rescue and Breeding Program" being undertaken by the University of Southern Mindanao (USM) and the Local Government of North Cotobato Province, through the Office of the Governor. Funds for the first year of this project were received from Melbourne Zoo (Australia) through Mr. Chris Banks ($US1000), Mr. Curt L. Harbsmeier through the CSG ($US1000), Utairatch Crocodile Farm (Thailand) through Mr. Uthen Youngprapakorn ($US3000), and a local Philippine donor (80,000 PhP). Continuation funds, estimated at $US1000 per year, have been pledged by Utairatch Crocodile Farm for the next several years. After that time it is hoped the project will be self-sustained through provincially generated funds.

The main objective of this project is to jointly coordinate and carry out the establishment of a rescue and breeding center for *Crocodylus mindorensis* that will utilize 'surplus' individuals for captive breeding and return the resultant young to protected areas in the marsh. Seven adult *C. mindorensis* are available for donation to this project at this time. The sex of several of these crocodiles is unknown, but at least two breeding pairs (in two pens) can be established and maintained. Construction of growout and breeding pens will be assigned at the Capitol complex close to a wildlife park. These pens will be approximately 20 m^2 and will utilize natural habitats with ponds and swampy wetlands.

Progeny from this project will be released in an area already identified as a culturally protected or spiritually created crocodile sanctuary. This area, Sadsalan Sitio, is located in the heart of Ligawasan Marsh and considered by the locals as having the largest population of *C. mindorensis* in the marsh. Owing to locally enforced traditional laws, and very restricted access to this area, human predation on the released crocodiles is expected to be minimal [Datu G. Mangansay, II. (2008). Crocodile symbolism in Maguindanaoan culture. Proceedings of the Forum on Crocodiles in the Philippines. National Museum Papers 14: 133-139]. Release into the sanctuary will occur within 2 or 3 months of hatching at the rescue centre. All crocodiles will be permanently marked for future identification and/or use in a future mark/recapture population density, and/or, successful recruitment study.

It must be stressed that creation of this rescue center will not create any additional threat or pressure on the wild population in Ligawasan Marsh. As only crocodiles donated free of charge and already identified as captive will be accepted and utilized, it will suggest to poachers that their commercial market is small.

We would like to also inform the CSG that the indigenous people of the marsh, "Children of the marsh", have just requested USM and CPPI for assistance in obtaining a special designation of 28,000 ha in the marsh as an inviolate crocodile sanctuary under local ordinances. The Ligawasan Marsh is the single most critical habitat for *C. mindorensis* which owes much to the sympathy and understanding of the local populace and difficulty in egress.

Vic Mercado, *President, Crocodylus Porosus Philippines, Inc.*

REQUEST FOR STUDENT PROPOSALS: CROCODILE BIOLOGY AND NATURAL HISTORY. Crocodylus Porosus Philippines, Inc. (CPPI) a non-profit organization consisting of 6 crocodile farms in the Philippines, is committed to pursuing and facilitating the conservation, and sustainable use of crocodiles in the Philippines. In this regard, CPPI has decided to actively solicit project proposals dealing with crocodiles in the Philippines from qualified undergraduate or postgraduate college students residing and studying in the Philippines. Projects dealing with field biology will be given priority.

Grants of up to 1000 Philippine Pesos will be awarded to successful proposals. These grants are not aimed at full support of a student/project, but represents an assistance, which hopefully can be matched by their institution in either stipend, salary, waiver of overhead, supplies, and/or other needs. Acceptance and award of funds from CPPI can also be used in conjunction with applications to other similar grant programs such as the Crocodile Specialists Group's "Student Research Assistance Scheme".

Grant proposals should be submitted to CPPI by email at <bmerca@attglobal.net> and copied to <microlabphils@attglobal.net>, with subject header "Attn. CPPI Student Grant Program".

A proposal cover sheet with a project abstract is required. Proposal should not exceed 4 pages and should not include common knowledge phrases such as "endangered crocodile species", etc. Proposals should be accompanied by a statement of support from the student's academic institution.

This invitation is being distributed to all institutions of higher learning with the assistance of the Center for Higher Education in the Philippines (CHED), and Silliman University.

Vic Mercado, *President, Crocodylus Porosus Philippines, Inc*.

North America

USA

ALLIGATOR DNA USED TO CHARGE POACHER. Florida investigators used DNA analysis of American alligator (*Alligator mississippiensis*) blood to arrest and charge a Pompano Beach man with illegally killing an alligator. The man was witnessed killing the alligator and loading the body into a truck last October. When interviewed by wildlife officers, the man denied killing the alligator, and claimed the blood in the truck was from rabbits taken during a hunting trip.

Samples of the blood from the truck were taken and analysed at the State's wildlife forensics laboratory in Boca Raton, and compared to blood taken from the scene of the killing. The DNA matched. This is the first poaching case using alligator DNA, although the laboratory has been used for cases involving other animals (eg deer, turtles).

Source: David Fleshler, *Sun Sentinel, 28 May 2010.*

Science

Recent Publications

Jones, D.R. and Gardner, M. (2010). Ring around the heart: an unusual feature of the crocodilian central circulatory system. Australian Zoologist 35(2): 146-152.

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Mahur, M., Bhatnagar, C. and Koli, V.K. (2010).Some observations on basking behaviour of a wild population of Marsh crocodiles in Baghdarrah Lake, Udaipur, Rajasthan, India. Tigerpaper 37(1): 1-7.

Benga, G., Chapman, B.E., Cox, G.C. and Kuchel, P.W. (2010). Comparative NMR studies of diffusional water permeability of red blood cells from different species: XVIII platypus (*Ornithorhynchus anatinus*) and saltwater crocodile (*Crocodylus porosus*). Cell Biol. Int. 34(7): 703-708.

Abstract: As part of a program of comparative measurements of diffusional water permeability (Pd) the red blood cells (RBCs) from an aquatic monotreme, platypus (*Ornithorhynchus anatinus*) and an aquatic reptile, saltwater crocodile (*Crocodylus porosus*) were studied. The mean diameter of platypus RBCs was estimated by light microscopy and found to be ~6.3 mum. Pd was measured by using an Mn^2+-doping 1H nuclear magnetic resonance (NMR) technique. The Pd (cm s^{-1}) values were relatively low: ~2.1 x 10^{-3} at 25°C, 2.5 x 10^{-3} at 30°C, 3.4 x 10^{-3} at 37°C and 4.5 at 42°C for the platypus RBCs and ~2.8 x 10^{-3} at 25°C, 3.2 x 10^{-3} at 30°C, 4.5 x 10^{-3} at 37°C and 5.7 x 10^{-3} at 42°C for the crocodile RBCs. In parallel with the low water permeability the activation energy of water diffusion (Ea,d) was relatively high, ~35 kJ mol^{-1}. These results suggest that "conventional" water channel proteins (WCPs), or aquaporins (AQPs), are probably absent from the plasma membranes of RBCs from both the platypus and the saltwater crocodile.

Farmer, C.G. and Sanders, K. (2010). Unidirectional airflow in the lungs of alligators. Science 327(5963): 338-340.

Abstract: The lungs of birds move air in only one direction during both inspiration and expiration through most of the tubular gas-exchanging bronchi (parabronchi), whereas in the lungs of mammals and presumably other vertebrates, air moves tidally into and out of terminal gas-exchange structures, which are cul-de-sacs. Unidirectional flow purportedly depends on bellowslike ventilation by air sacs and may have evolved to meet the high aerobic demands of sustained flight. Here, we show that air flows unidirectionally through parabronchi in the lungs of the American alligator, an amphibious ectotherm without air sacs, which suggests that this pattern dates back to the basal archosaurs of the Triassic and may have been present in their nondinosaur descendants (phytosaurs, aetosaurs, rauisuchians, crocodylomorphs, and pterosaurs) as well as in dinosaurs.

Peterka, M., Yves Sire, J., Hovorakova, M., Prochazka, J., Fougeirol, L., Peterkova, R. and Viriot, L. (2010). Prenatal development of *Crocodylus niloticus niloticus* Laurenti, 1768. J. Exp. Zool. B Mol. Dev. Evol. 314(5): 353-368.

Abstract: Prenatal development in crocodilians represents a very interesting model for comparative studies. As the speed of prenatal development of crocodilians varies depending on incubation conditions, the staging of embryos and fetuses is a very important prerequisite for data correlation. To establish a background for future developmental studies on *Crocodylus niloticus*, we characterized its prenatal development in a collection comprising 169 animals during embryonic/incubation days 9-70. The characteristics included external morphology, head morphometry, and wet body weight determined before fixation. We documented the external morphology of prenatal Nile crocodiles in a large collection of photographs and described landmarks during the morphogenesis of the head, face and limbs. In the development of the facial processes (medial nasal, lateral nasal, maxillary), three phases could be distinguished: union, separation, reunion. At the free jaw margin, a regular series of prominences was present. The outer aspect of a prominence gave rise to a labial scale, the inner aspect to a tooth. In contrast to mammals (humans and mice), the hindlimbs of *C. niloticus* developed faster than the forelimbs. We also determined changes in basic measures of the head and of the wet body weight. Both morphological and morphometric characteristics showed an apparent inter-individual variability among animals of the same age. This variability decreased among animals of a similar body weight (irrespective of their age). Body weight can be considered as the most representative and complex parameter for crocodile staging reflecting the overall growth of a whole embryo/fetus.

Martelli, P., Lai, O,R., Krishnasamy, K., Langelet, E., Marín, P., Laricchiuta, P. and Crescenzo, G. (2009). Pharmacokinetic behavior of enrofloxacin in estuarine crocodile (*Crocodylus porosus*) after single intravenous, intramuscular, and oral doses. J. Zoo. Wildl. Med. 40(4): 696-704.

Abstract: The disposition kinetics of enrofloxacin at a single dose of 5 mg/kg body weight were determined in clinically healthy captive-reared estuarine crocodiles (*Crocodylus porosus*) after intravenous (i.v.), intramuscular (i.m.), and oral (p.o.) administration. Enrofloxacin plasma concentrations were determined by diode array detection-high-performance liquid chromatography (limit of detection/limit of quantitation: 0.05 microg/ml). Data were subjected to noncompartmental analysis. The integrated pharmacokinetic-pharmacodynamic (PK-PD) variables showed that optimal area under the curve from the time of dosing to 24 hr: minimal inhibitory concentration (MIC) (>125) and peak plasma concentrations:MIC (>8) ratios, as reported for concentration-dependent bactericidal antimicrobials like fluoroquinolones, were achievable with both a single i.v. or i.m. dose for susceptible microorganisms with MIC values of < or =0.5 microg/ml, while the relatively slow onset of peak time allowed an effective plasma drug level only on day 3. The persistence of useful plasma concentrations indicated the possibility of redosing every 3 day for parenteral routes of administration, while further studies are needed for the oral route. Nevertheless, the absence of adverse reactions in the animals following i.v., i.m., or p.o. administration of enrofloxacin after a single dose of 5 mg/kg indicates the possibility of its safe and effective clinical use in captive estuarine crocodiles.

Rockloff, M.J. and Greer, N. (2010). Never smile at a crocodile: Betting on electronic gaming machines is intensified by reptile-induced arousal. J. Gambl. Stud.

Abstract: Tourists at the Koorana Saltwater Crocodile Farm in Coowonga, Queensland, Australia, including 62 males and 41 females, aged 18-66 (M= 34.2, SD= 13.3), were randomly assigned to play a laptop-simulated Electronic Gaming Machine (EGM) either: (1) prior to entry, or (2) after having held a 1-m saltwater-crocodile. Gambling behavior; including bet-size, speed of betting, final payouts and trials played on the EGM; was investigated with respect to participants' assigned arousal condition, problem-gambling status, and affective state. At-risk gamblers with few self-reported negative emotions placed higher average bets at the EGM after having held the crocodile when compared to the control. In contrast, at-risk gamblers with many self-reported negative emotions placed lower average bets at the EGM after having held the crocodile. The results suggest that high arousal can intensify gambling in at-risk players, but only if this feeling state is not perceived as a negative emotion.

Kumagai, C. and Farlow, J.O. (2010). Morphometric analysis of the American crocodile (*Crocodylus acutus*). Geological Society of America Abstracts with Programs 42(2): 93.

Abstract: When comparing fossil tracks, particularly in the same assemblage, identifying the number of track makers is of great interest to ichnologists. To accomplish this task, various features of the tracks are surveyed and the tracks that are most similar are assigned to an ichnospecies and, by extension, potentially the same trackmaker. This method works well

with trackways and prints that have distinctly different morphological features. However, when considering prints that share a similar morphology, there is a possibility that the tracksite contains tracks that are a collection of prints from one species in various stages of growth rather than several adult species that share similar autopodial morphology. The extent of variation in autopodial morphology can affect the extent of variation found in trackways and understanding the extent of variation within a species can help resolve this issue. In this regard, several (ca. 60) wild specimens of the American crocodile (*Crocodylus acutus*) were captured and measured for morphometric analysis. Preliminary results show a close correlation (little variation) between the size of the animal (length of the animal, manus and pes lengths) and several autopodial measurements. These preliminary results suggest certain limits or allowances on intraspecific variation that may be present in a fossil crocodylian track assemblage; and, by extension, possibly other extinct archosaurs.

Allen, V., Elsey, R.M., Jones, N., Wright, J. and Hutchinson, J.R. (2010). Functional specialization and ontogenetic scaling of limb anatomy in *Alligator mississippiensis*. 216(4): 423-445.

Abstract: Crocodylians exhibit a fascinating diversity of terrestrial gaits and limb motions that remain poorly described and are of great importance to understanding their natural history and evolution. Their musculoskeletal anatomy is pivotal to this diversity and yet only qualitative studies of muscle-tendon unit anatomy exist. The relative masses and internal architecture (fascicle lengths and physiological cross-sectional areas) of muscles of the pectoral and pelvic limbs of American alligators (*Alligator mississippiensis* Daudin 1801) were recorded for an ontogenetic series of wild specimens (n = 15, body masses from 0.5 to 60 kg). The data were analysed by reduced major axis regression to determine scaling relationships with body mass. Physiological cross-sectional areas and therefore muscle force-generating capacity were found to be greater in the extensor (anti-gravity) muscles of the pelvic limb than in the pectoral limb, reflecting how crocodylians differ from mammals in having greater loading of the hindlimbs than the forelimbs. Muscle masses and architecture were generally found to scale isometrically with body mass, suggesting an ontogenetic decrease in terrestrial athleticism. This concurs with the findings of previous studies showing ontogenetic decreases in limb bone length and the general scaling principle of a decline of strength : weight ratios with increasing size in animals. Exceptions to isometric scaling found included positive allometry in fascicle length for extensor musculature of both limbs, suggesting an ontogenetic increase in working range interpreted as increasing postural variability - in particular the major hip extensors - the interpretation of which is complicated by previous described ontogenetic increase of moment arms for these muscles.

Moore, B.C., Hamlin, H.J., Botteri, N.L., Lawler, A.N., Mathavan, K.K. and Guillette, L.J. (2009). Posthatching development of *Alligator mississippiensis* ovary and testis. J. Morphol. 271(5): 580-595.

Abstract: We investigated ovary and testis development of *Alligator mississippiensis* during the first 5 months posthatch. To better describe follicle assembly and seminiferous cord development, we used histochemical techniques to detect carbohydrate-rich extracellular matrix components in 1-week, 1-month, 3-month, and 5-month-old gonads. We found profound morphological changes in both ovary and testis. During this time, oogenesis progressed up to diplotene arrest and meiotic germ cells increasingly interacted with follicular cells. Concomitant with follicles becoming invested with full complements of granulosa cells, a periodic acid Schiff's (PAS)-positive basement membrane formed. As follicles enlarged and thecal layers were observed, basement membranes and thecal compartments gained periodic acid-methionine silver (PAMS)-reactive fibers. The ovarian medulla increased first PAS- and then PAMS reactivity as it fragmented into wide lacunae lined with low cuboidal to squamous epithelia. During this same period, testicular germ cells found along the tubule margins were observed progressing from spermatogonia to round spermatids located within the center of tubules. Accompanying this meiotic development, interstitial Leydig cell clusters become more visible and testicular capsules thickened. During the observed testis development, the thickening tunica albuginea and widening interstitial tissues showed increasing PAS- and PAMS reactivity. We observed putative intersex structures in both ovary and testis. On the coelomic aspect of testes were cell clusters with germ cell morphology and at the posterior end of ovaries, we observed "medullary rests" resembling immature testis cords. We hypothesize laboratory conditions accelerated gonad maturation due to optimum conditions, including nutrients and temperature. Laboratory alligators grew more rapidly and with increased body conditions compared with previous measured, field-caught animals. Additionally, we predict the morphological maturation observed in these gonads is concomitant with increased endocrine activities.

Pritz, M.B. (2010). Forebrain and midbrain fiber tract formation during early development in Alligator embryos. Brain Res. 1313: 34-44.

Abstract: The relationship between fiber tract formation and transverse and longitudinal borders of the diencephalon was investigated in *Alligator* embryos beginning when this structure was a single unit and continuing until internal subgroups were present within individual segments. At all stages of development, distinct bundles of fibers were not restricted to borders between morphological segments nor were they located at the alar/basal plate boundary. With the exception of a few fine fibers that occupied only a part of certain inter-diencephalic boundaries, fiber tracts were present within the parenchyma of respective subdivisions. In the process of this analysis, fiber tract formation was also documented in the telencephalon, secondary prosencephalon, and midbrain during this period of early development. Fiber tracts were classified into three groups based on orientation:

transverse; longitudinal; and commissural. At early stages of development, similarities between *Alligator* and other species suggest that these bundles represent a primary scaffold for all vertebrates with two exceptions. One was the presence of the descending tract of the mesencephalic trigeminal nucleus in *Alligator* and other jawed animals but not in jawless vertebrates. The other was the absence of the dorsoventral diencephalic tract in *Alligator* which lacks a pineal gland.

Zapata, U., Metzger, K., Wang, Q., Elsey, R.M., Ross, C.F. and Dechow, P.C. (2009). Material properties of mandibular cortical bone in the American alligator, *Alligator mississippiensis*. Bone 46(3): 860-867.

Abstract: This study reports the elastic material properties of cortical bone in the mandible of juvenile *Alligator mississippiensis* obtained by using an ultrasonic wave technique. The elastic modulus, the shear modulus, and Poisson's ratio were measured on 42 cylindrical *Alligator* bone specimens obtained from the lingual and facial surfaces of 4 fresh Alligator mandibles. The data suggest that the elastic properties of alligator mandibular cortical bone are similar to those found in mammals and are orthotropic. The properties most resemble those found in the cortex of mammalian postcranial long bones where the bone is most stiff in one direction and much less stiff in the two remaining orthogonal directions. This is different from cortical bone found in the mandibles of humans and somes monkeys, where the bone has greatest stiffness in one direction, much less stiffness in another direction, and an intermediate amount in the third orthogonal direction. This difference suggests a relationship between levels of orthotropy and bending stress. The comparability of these elastic moduli to those of other vertebrates suggest that the high bone strain magnitudes recorded from the alligator mandible *in vivo* are not attributable to a lower stiffness of alligator mandibular bone.

Al-Hashimi N., Lafont, A.G., Delgado, S., Kawasaki, K. and Sire, J.Y. (2010). The enamelin genes in lizard, crocodile and frog, and the pseudogene in the chicken provide new insights on enamelin evolution in tetrapods. Mol. Biol. Evol. doi:10.1093/molbev/msq098.

Abstract: Enamelin (ENAM) has been shown to be a crucial protein for enamel formation and mineralization. Previous molecular analyses have indicated a probable origin early in vertebrate evolution, which is supported by the presence of enamel/enameloid tissues in early vertebrates. In contrast to these hypotheses, ENAM was only characterized in mammals. Our aims were to (i) look for ENAM in representatives of non-mammalian tetrapods, (ii) search for a pseudogene in the chicken genome, and (iii) see whether the new sequences could bring new information on ENAM evolution. Using in silico approach and PCR, we obtained and characterized the mRNA sequences of ENAM in a frog, a lizard and a crocodile, the genomic DNA (gDNA) sequences of ENAM in a frog and a lizard, and the putative sequence of chicken ENAM pseudogene. The comparison with mammalian ENAM sequences has revealed (i) the presence of an additional coding exon, named exon 8b, in sauropsids and marsupials, (ii) a simpler 5' untranslated region in non-mammalian ENAMs, (iii) many sequence variations in the large exons while there are a few conserved regions in small exons, and (iv) 25 amino acids that have been conserved during 350 million years of tetrapod evolution and hence of crucial biological importance. The chicken pseudogene was identified in a region that was not expected when considering the gene synteny in mammals. Together with the location of lizard ENAM in a homologous region this result indicates that enamel genes were probably translocated in an ancestor of the sauropsid lineage. This study supports the origin of ENAM earlier in vertebrate evolution, confirms that tooth loss in modern birds led to the invalidation of enamel genes, and adds information on the important role played by, e.g., the phosphorylated serines and the glycosylated asparagines for correct ENAM functions.

Cramp, R.L., Hudson, N.J. and Franklin, C.E. (2010). Activity, abundance, distribution and expression of Na+/K+-ATPase in the salt glands of *Crocodylus porosus* following chronic saltwater acclimation. J. Exp. Biol. 213(8): 1301-1308.

Abstract: Saltwater crocodiles, *Crocodylus porosus*, possess lingual salt glands which function to remove excess Na(+) and Cl(-) accumulated as a consequence of living in salt water. Little is known about the nature of ion transport systems in *C. porosus* salt glands and how these systems respond to an osmotic challenge. In the present study, we examined the distribution and regulation of the Na(+)/K(+)-ATPase (NKA) pump, specifically the alpha-(catalytic) subunit in the salt glands of *C. porosus* chronically acclimated (6 months) to freshwater (FW) or 70% seawater (SW). We hypothesised that in the SW-acclimated *C. porosus* there would be an up-regulation of the abundance, activity and gene expression of the NKA transporter. NKA was immunolocalised to the lateral and basal membrane of secretory cells. As predicted, the NKA alpha-subunit was 2-fold more abundant in SW-acclimated *C. porosus* salt glands. NKA gene expression was also elevated in the salt glands of SW- vs FW-acclimated crocodiles. There was no increase in the specific activity of NKA in SW-acclimated animals and the *in vitro* rate of oxygen consumption by salt gland slices from SW-acclimated animals was not significantly different from that of FW-acclimated animals. The proportion of tissue oxygen consumption rate attributable to NKA activity was not different between SW- and FW-acclimated animals (approximately 50%). These data suggest that either chronic SW acclimation does not affect NKA in crocodile salt glands in the same manner as seen in other models or crocodiles possess the capacity to moderate NKA activity following prolonged exposure to SW.

Farmer, C.G. and Sanders, K. (2010). Unidirectional airflow in the lungs of alligators. Science 327(5963): 338-340.

Abstract: The lungs of birds move air in only one direction during both inspiration and expiration through most of the

tubular gas-exchanging bronchi (parabronchi), whereas in the lungs of mammals and presumably other vertebrates, air moves tidally into and out of terminal gas-exchange structures, which are cul-de-sacs. Unidirectional flow purportedly depends on bellowslike ventilation by air sacs and may have evolved to meet the high aerobic demands of sustained flight. Here, we show that air flows unidirectionally through parabronchi in the lungs of the American alligator, an amphibious ectotherm without air sacs, which suggests that this pattern dates back to the basal archosaurs of the Triassic and may have been present in their nondinosaur descendants (phytosaurs, aetosaurs, rauisuchians, crocodylomorphs, and pterosaurs) as well as in dinosaurs.

Garrison, A.W., Guilette, L.J. Jr., Wiese, T.E. and Avants, J.K. (2010). Persistent organochlorine pesticides and their metabolites in alligator livers from Lakes Apopka and Woodruff, Florida, USA. Int. J. Environ. Analytical Chem. 90(2): 159-170.

Abstract: Reproductive disorders in American alligators (*Alligator mississippiensis*) inhabiting Lake Apopka, Florida, have been observed for several years. Such disorders are hypothesised to be caused by endocrine disrupting contaminants occurring in the lake due to pesticide spills and runoff from bordering agricultural lands. Various studies have resulted in identification of several persistent chlorinated organic pollutants, some of them known endocrine disrupters, in various alligator tissues and fluids. In this report, livers from 12 juvenile alligators inhabiting Lake Apopka and 10 from Lake Woodruff, a control lake, were extracted and analysed using gas chromatography-mass spectrometry with chiral GC columns for identification of both chiral and non-chiral organochlorine pesticides (OCPs, including their metabolites); in so doing, the enantiomer fractions of any chiral OCPs identified were also measured. In Lake Apopka, *p,p*'-DDE was the most prominent OCP identified, being found in all samples at concentrations ranging from 4 to 779 $ng.g^{-1}$, based on wet weight of the liver samples. *Trans*- and *cis*-nonachlor were also detected in all samples at a concentration range of 0.3 to 64 $ng.g^{-1}$; *p,p*'-DDD was also detected in all samples, but at an even lower concentration of 0.2 to 11 $ng.g^{-1}$. Only 5 chiral OCPs were identified; their enantiomer fractions were mostly non-racemic, indicating pre-ingestion enantioselective biotransformation or enantioselective metabolism by the alligators. p,p'-Dichlorobenzophenone (*p,p*'-DCBP), a known metabolite of *p,p*'-dicofol, was detected in all but one sample; most concentrations were <1 $ng.g^{-1}$. Dicofol is known to have been used and spilled near Lake Apopka, and is highly toxic to fish and aquatic invertebrates. Experiments showed that the *p,p*'-DCBP identified in these samples occurred via thermal degradation during GC analysis of *p,p*'-dicofol that was present in the liver sample extracts. Only 5 OCPs, at levels much below those in Lake Apopka, were found in control Lake Woodruff.

Owerkowicz, T., Andrade, F., Elsey, R. and Hicks, J. (2010). Atmospheric hypoxia increases bone robusticity in the American alligator. The FASEB Journal 24: 988.4.

Abstract: During vertebrate evolution, atmospheric oxygen (O_2) level may have varied from as low as 12% to as high as 30%, but no studies to date have considered the effect of ambient O_2 on skeletal plasticity. We incubated eggs and subsequently grew alligator hatchlings under chronic hypoxia (12% O_2), normoxia (21% O_2) and hyperoxia (30% O_2). Animals received monthly injections of fluorescent dyes to determine bone deposition rates. After 3 months, animals were sacrificed and their femora either sectioned at mid-diaphysis, or ashed. We found femora of hypoxic alligators to have significantly greater mass-specific cross-sectional area (+15%), second moment of area (+20%) and polar moment of inertia (+23%) than those of either normoxic or hyperoxic hatchlings. Mineral content was also significantly higher (+6%) in bones of hypoxic animals. This suggests that exposure to chronic hypoxia, but not hyperoxia, resulted in increased resistance to compressive, bending and torsional stresses on the skeleton. Furthermore, the relationship between body mass growth and periosteal deposition rate was different between treatments groups, with hypoxic animals accruing more bone per unit body mass. We suggest that prevalent atmospheric O_2 level need be considered when reconstructing size and growth curves of extinct vertebrates.

Owerkowicz, T., Eme, J., Gwalthney, J., Blank, J.M. and Hicks, J.W. (2010). Cardiac shunting does not constrain aerobic capacity of the American alligator. Exp. Biol.

Abstract: Despite having a similar four-chambered heart, crocodilians and birds differ widely in their aerobic capacity. We investigated whether this is due to differences in outflow tract design, which allows for cardiac shunting in crocodilians, but not in birds. We hypothesized that removal of cardiac shunt will improve aerobic capacity (VO_2max) by forcing the entire right ventricular ejection volume to the lungs. We surgically occluded the left aorta in alligator hatchlings to render them incapable of shunting. After 17 months of growth and exercise training, we subjected alligators to a graded treadmill exercise test and measured their VO_2max. We found no significant difference in VO_2max between surgically-altered (7.7 ml O_2/kg/min) and sham-operated (8.0 ml O_2/kg/min) alligators. To further test whether cardiac shunting occurs during exercise, we measured blood flow in the left and right aortae. Shunting (net forward flow in the left aorta) occurred at rest in undisturbed animals, disappeared at the onset of forced exercise, and returned slowly during undisturbed recovery. This suggests cardiac shunting ability does not limit aerobic performance in crocodilians, because the shunt is turned off during exercise. We propose that non-avian theropods may have continued to enjoy benefits of cardiac shunting, even as they evolved a more superior aerobic capacity.

Owerkowicz, T., Tsai, H.P., Sanchez, L., Felbinger, K., Andrade, F., Blank, J.M., Eme, J., Gwalthney, J. and Hicks, J.W. (2010). Chronic exercise does not alter limb bone

morphology or microstructure in the American alligator. Exp. Biol.

Abstract: In contrast to mammals and birds, effects of exercise on bone microstructure in reptiles have received scant attention. We investigated the effects of long-term exercise on a treadmill or in a flume on limb bones of the American alligator. Juvenile alligators were run or swum to exhaustion every other day for 17 months, and received fluorescent dye injections to determine bone deposition rates. We found no significant differences in whole bone morphology and cortical bone deposition rates in the alligator humeral or femoral midshaft, regardless of exercise regimen. Similarly, we found no effects of either exercise regimen on trabecular number, thickness or density in the distal femur. In addition, bone mineral content was similar across exercise groups. Altogether, this suggests that long-term exercise has no discernible effect on bone microstructure in alligators. These results stand in contrast to studies on endothermic vertebrates. The disparity could be due to metabolic differences between ectothermic and endothermic vertebrates. An alternative explanation is that alligator limb bones are subjected to insufficient strain levels or load cycles during short exercise bouts, which may account for lack of bone remodelling in response to exercise in alligators.

Nelson, T.C., Groth, K.D. and Sotherland, P,R. (2010). Maternal investment and nutrient use affect phenotype of American alligator and domestic chicken hatchlings. Comp Biochem Physiol A Mol Integr Physiol.

Abstract: Maternal investment by oviparous amniotes, in the form of yolk and albumen, and the mechanisms by which embryos use available energy and nutrients have a profound effect on embryo and, consequently, hatchling phenotype. Nutrient provisioning and uptake varies within and among oviparous taxa, avian and non-avian reptiles, due to differences and similarities in environment, behavior, and phylogeny. Eggs of crocodilians, the closest extant relatives to modern birds, are ideal models for examining modes of embryonic development, especially with regard to nutrient uptake, in non-avian reptiles and comparing them with those of birds. In this study, we investigated egg composition, embryo growth, and nutrient use in the domestic chicken (*Gallus gallus*) and American alligator (*Alligator mississippiensis*). We explored egg composition by separating and weighing components of fresh eggs. We measured embryo growth and nutrient usage by dissecting embryos and by obtaining samples of liquid from the amnion, digestive tract, and yolk sac throughout the last half of incubation. Variation in albumen mass contributed most to egg mass variation in chicken eggs, whereas alligator eggs were composed almost equally of yolk and albumen, although larger eggs contained proportionally more albumen and less yolk than smaller eggs. Both chicken and alligator albumen were mostly water (87% and 96%, respectively) although chicken albumen contained over three times more solid mass per gram than alligator albumen. In both species, yolk contained a high proportion of solids. Larger eggs produced larger hatchlings in both chickens and alligators, but albumen solids contributed to embryo mass only in chicken embryos. However, intact albumen proteins appeared in the stomach in embryos of both species. While the final disposition of albumen in alligators is unclear, variation in maternal investment of yolk at oviposition was responsible for nearly all of the variation in alligator hatchling phenotype, while both yolk and albumen contributed to chicken hatchling mass.

Fujiwara, S., Taru, H. and Suzuki, D. (2010). Shape of articular surface of crocodilian (Archosauria) elbow joints and its relevance to sauropsids. J. Morphol. 271(7): 883-896.

Abstract: The determination of area and shape of articular surfaces on the limb bones of extinct archosaurs is difficult because of postmortem decomposition of the fibrous tissue and articular cartilages that provide the complex three-dimensional joint surfaces in vivo. This study aims at describing the shape of the articular cartilages in the elbow joints of six crocodilian specimens; comparing its structure with that of four birds, three testudines, and five squamates; and comparing the shapes of the surfaces of the calcified and the articular cartilages in the elbow joints of an Alligator specimen. The shapes of the articular cartilages of crocodilian elbow joint are shown to resemble those of birds. The humerus possesses an olecranon fossa positioned approximately at the midportion of the distal epiphysis and bordering the margin of the extensor side of the articular surface. The ulna possesses a prominent intercotylar process at approximately the middle of its articular surface, and splits the surface into the radial and ulnar cotylae. This divides the articular cartilage into an articular surface on the flexor portion, and the olecranon on the extensor portion. The intercotylar process fits into the olecranon fossa to restrict elbow joint extension. Dinosaurs and pterosaurs, phylogenetically bracketed by Crocodylia and Aves (birds), may have possessed a similar olecranon fossa and intercotylar process on their articular cartilages. Although these shapes are rarely recognizable on the bones, their impressions on the surfaces of the calcified cartilages provide an important indication of the extensor margin of the articular surfaces. This, in turn, helps to determine the maximum angle of extension of the elbow joint in archosaurs.

Larsson, H.C., Heppleston, A.C. and Elsey, R.M. (2010). Pentadactyl ground state of the manus of *Alligator mississippiensis* and insights into the evolution of digital reduction in Archosauria. J. Exp. Zool. B Mol. Dev. Evol.

Abstract: The three-fingered state of the avian manus poses intriguing questions about the evolution of digit reduction. Although digit reduction in most tetrapods appears to be the product of straightforward digit loss, avian digit reduction may have occurred with a dissociation of digit position from digit identity. The three digits of birds have the ancestral identities of I, II, and III but develop from an early pentadactyl ground state from digital anlage 2, 3, and 4. A series of hypotheses have been proposed in an attempt to explain this disparity, including a recent suggestion that the

anteriormost condensation visible in the avian limb bud is in fact a vestigial structure from a hexadactyl ancestral ground state. We investigated this proposal by presenting sets of compatible evolutionary developmental trajectories starting from a hexadactyl state to test hypotheses of digit reduction. The development of skeletogenic mesenchymal condensations in a crocodylian, the closest extant relative to birds, is used to identify any extra precartiloginous digital vestiges. A developmental series of *Alligator mississippiensis* forelimb buds reveal only five digital anlagen, supports a pentadactyl ground state for the archosaurian manus, and rejects portions of the evolutionary developmental trajectories proposed. This condition lends further support to the contribution of a homeotic transformation during digit reduction in avian ancestry to account for the dissociation between digital identity and developmental position.

Witmer, G.W., Eisemann, J.D., Primus, T.M., O'Hare, J.R., Perry, K.R., Elsey, R.M. and Trosclair, P.L. III (2010). Assessing potential risk to alligators, *Alligator mississippiensis*, from nutria control with zinc phosphide rodenticide baits. Bull. Environ. Contam. Toxicol. 84(6): 698-702.

Abstract: Nutria, *Myocastor coypus*, populations must be reduced when they cause substantial wetland damage. Control can include the rodenticide zinc phosphide, but the potential impacts to American alligators, *Alligator mississippiensis*, must be assessed. The mean amount of zinc phosphide per nutria found in nutria carcasses was 50 mg. Risk assessment determined that a conservative estimate for maximum exposure would be 173 mg zinc phosphide for a 28 kg alligator, or 6.2 mg/kg. Probit analysis found an LD(50) for alligators of 28 mg/kg. Our studies suggest that the use of zinc phosphide to manage nutria populations would pose only a small risk to alligators.

Vickaryous, M.K. and Hall, B.K. (2010). Comparative development of the crocodylian interclavicle and avian furcula, with comments on the homology of dermal elements in the pectoral apparatus. J. Exp. Zool. B Mol. Dev. Evol. 314(3): 196-207.

Abstract: The pectoral apparatus (shoulder girdle plus sternum) of amniotes plesiomorphically includes an unpaired element of dermal origin. In crocodylians, lepidosaurs, and nontherian synapsids (monotremes and their ancestors) this element is identified as the interclavicle, in Testudines (turtles and tortoises) as the entoplastron, and in Aves as the furcula. We investigated embryonic development of the interclavicle in *Alligator mississippiensis* (American alligator) and of the furcula in *Gallus gallus* (domestic chicken). The interclavicle and furcula are among the first skeletal elements to ossify, beginning at Ferguson stage 19 (*Alligator*) and Hamburger and Hamilton stage 33 (*Gallus*). Both elements: occupy a similar mid-ventral position within the pectoral apparatus; develop from paired (bilateral) cell condensations; never coexist at anytime during ontogeny or in the adult; and undergo intramembranous (ie direct) ossification. For both the interclavicle and the furcula, the initial onset of ossification is concomitant with mineralization of elements of the dermatocranium, and occurs in advance of mineralization of the replacement bones (eg scapula, metacoracoid) of the pectoral apparatus. Shortly after the initiation of ossification the paired condensations of both elements fuse. For each of *Alligator* and *Gallus*, only one pair of skeletogenic condensations is present during embryonic development. Based on these data and a review of the evolution and development of dermal elements in the pectoral apparatus, we conclude that the interclavicle is equally parsimonious as a homolog of the furcula.

Preecharram, S., Jearranaiprepame, P.,Daduang, S., Temsiripong, Y., Somdee, T., Fukamizo, T., Svasti, J., Araki, T. and Thammasiriraki, S. (2010). Isolation and characterisation of crocosin, an antibacterial compound from crocodile (*Crocodylus siamensis*) plasma. Animal Science Journal 81: 393-401.

Abstract: An antibacterial compound from crocodile blood was partially purified and functionally characterised. The freshwater crocodile (*Crocodylus siamensis*) plasma with antibacterial activity was partially purified by using a centrifugal concentrator and reverse phase high powered liquid chromatography, and designated as crocosin. Crocosin exhibits antibacterial activity toward *Salmonella typhi* and *Staphylococcus aureus*. Crocosin is thermostable and resistant to pronase digestion. The structure of crocosin analyzed by mass spectrometry contains repeating units of 94 and 136 m/z. Scanning electron microscopy indicates that crocosin probably penetrates progressively into cytoplasm space, perturbing and damaging bacterial membranes. Crocosin may provide an early defense mechanism toward bacterial infection in fresh water.

Nuñez Otaño, N.B., Imhof, A., Bolcatto, P.G. and Larriera, A. (2010). Sex differences in the genitalia of hatchling *Caiman latirostris*. Herpetological Review 41(1): 32-35.

Antelo, R.A., Ayarzagüena, J. and Castroviejo, J. (2010). Reproductive ecology of Orinoco crocodiles (*Crocodylus intermedius*) in a newly established population at El Frío Biological Station, Venezuela. Herp. J. 20: 51-58.

Abstract: We present data on the reproductive ecology of the Orinoco crocodile (*Crocodylus intermedius*) in a newly established population at the El Frío Biological Station, Venezuela, from 2003 to 2007. Nesting occurs during the dry season, and hatching of young takes place at the beginning of the rainy season. Elliptical hole-like nests are constructed in artificial sand beaches with a median nest depth of 42.6 cm. Nest depth is positively correlated with female total size, enabling us to predict the size of the female based on nest characteristics. Temperature in the egg chamber was on average 31.9°C. The thermal amplitude of the nest was positively correlated with nest depth, and less than 1.3°C

when the nest was deeper than 30 cm. The average clutch size was 41.2 eggs, the average clutch mass was 4256.2 g, and egg viability was 75.4%. The average length, width and weight of eggs was 7.61 cm, 4.73 cm and 111.07 g, respectively. As part of the conservation programme, we also artificially incubated eggs from the species. Hatching rate in the incubator was 84.3%. Total length and mass at hatching were 28.6 cm and 66.9 g, respectively. Our data demonstrate that head-starting our population through egg incubation is a suitable conservation strategy for this endangered species.

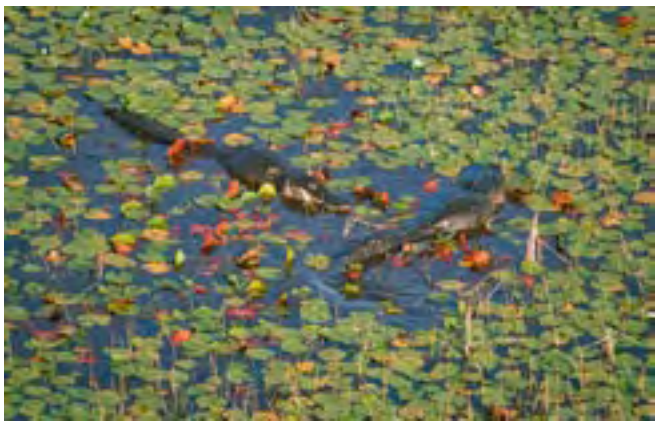
De Oliveira, D.P., Farias, I.P., Marioni, B., Campos, Z. and Hrbek, T. (2010). Microsatellite markers for mating system and population analyses of the spectacled caiman *Caiman crocodilus* (Linnaeus 1758). Conservation Genet. Resour. DOI 10.1007/s12686-010-9221-6

Abstract: We used a microsatellite enriched library to isolate and characterize 12 di-nucleotide microsatellite loci of *Caiman crocodilus*. Microsatellites were characterized in populations of *C. c. crocodilus* from Piagaçu-Purus, Amazonas, Brazil, and *C. c. yacare* from Cáceres, Mato Grosso, Brazil. Results of characterization were comparable between the two subspecies, with number of alleles varying from three to 20 and one to 14 per locus in *C. c. crocodilus* and *C. c. yacare*, respectively. Observed heterozygosities ranged from 0.088 to 0.816 and 0.115 to0.833, respectively. Joint paternity exclusion (QC) was[0.999 in both subspecies, and probability of genetic identity varied from 4.631 9 10-13 in *C. c. crocodilus* to 2.233 9 10-8 in *C. c. yacare*. All loci are unlinked, and with the exception of three loci in *C. c. crocodilus* all loci were at Hardy-Weinberg equilibrium. The characteristics of these loci makes them an excellent tool set for the study of mating systems, and fine-scaled population structuring in the *Caiman crocodilus* species complex.

ALLIGATORS IN ACTION! Patrick Lynch, Senior Media Designer with the South Florida Water Management District, was flying over Water Conservation Area One on 28 April in an aerial photographic survey of these wetlands near Wellington, west of West Palm Beach and southeast of nearby Lake Okeechobee. Seeing what appeared to be a spring of churning water, Lynch prompted helicopter pilot Mike Piccone to sweep back to the site so they could investigate. Hovering approximately 200 feet from the disturbed water, Lynch discovered that it was caused by two young male alligators engaged in a typical mating season bout - both alligators were so determined in their aggression toward each other that they were unphased by the helicopter hovering above them.

Lynch and Piccone watched for about four minutes before moving on, unable to determine if there was a victor, though the images reveal that one of the alligators had received a flesh wound over the left jugal bone.

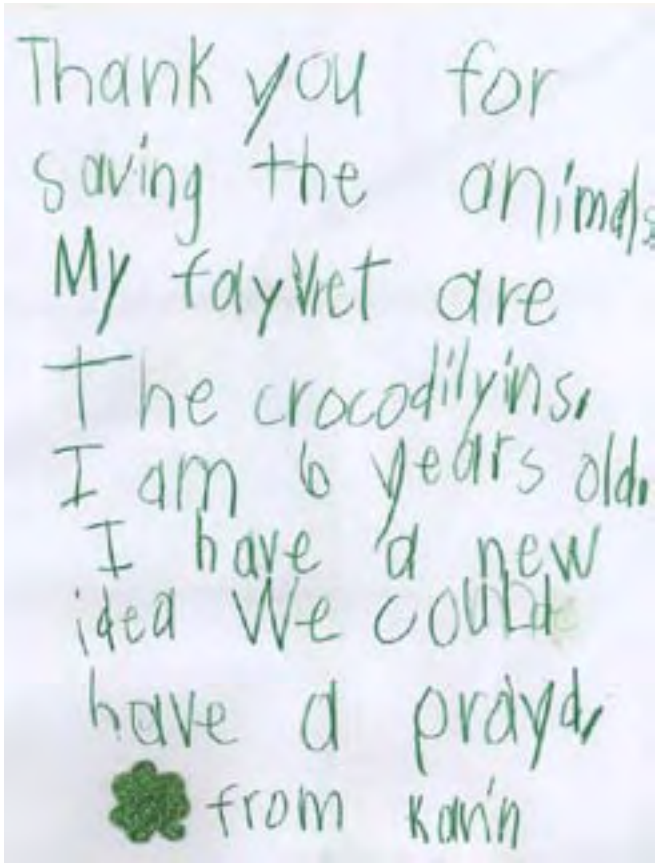
Acknowledgements: Photographs reproduced with the kind permission of Patrick Lynch and the South Florida Water Management District.



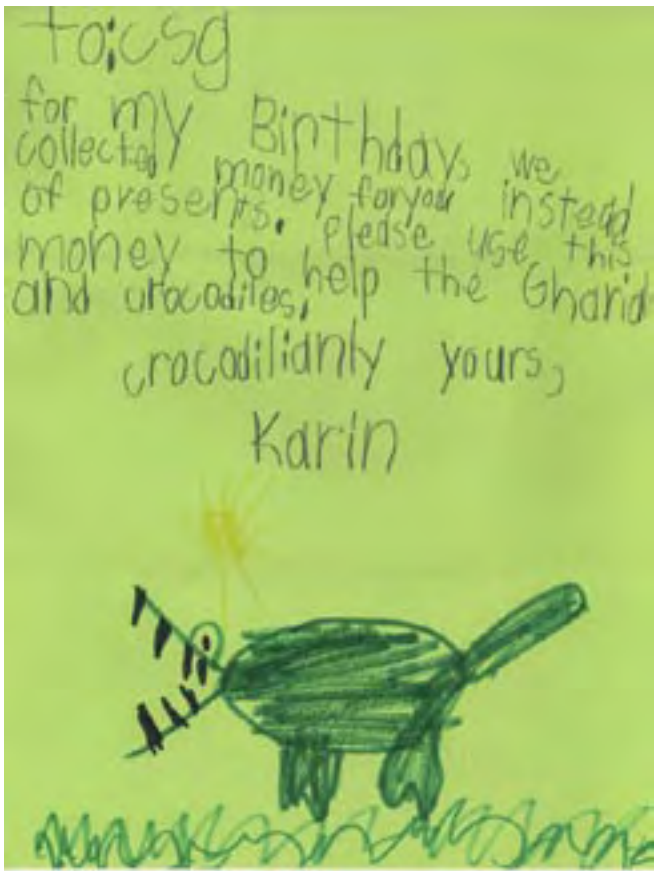
Israel Dupont <dupont@crocodopolis.net>.

Our Youngest CSG Member?

In May 2010 Ruth Skoug and Peter Ebey (New Mexico, USA) made a donation to the CSG, and enclosed a letter and drawing (see below) done by their daughter, Karin (6 y). According to her parents, Karin would love nothing better than to hop on a plane to India to personally save the Gharial - her favourite crocodilian. It was great to see such enthusiasm in someone so young.



n July 2010, just as this Newsletter was going to print, we received another letter from Karin, together with another donation to the CSG. But what was impressive this time was that Karin had decided to collect money in lieu of birthday presents, and had specifically earmarked it to "help the gharials and crocodiles". Again, a wonderful gesture on the part of a young crocodile conservationist. Thank-you Karin.



20th CSG Working Meeting

Location: The 20th CSG Working Meeting will be hosted by the Amazonas State Government, and held in the city of Manaus, Brazil.

Steering Committee Meeting: 12 September 2010

Working Meeting: 13-16 September 2010

Accommodation/Field Trips: Information on accommodation and field trips after the meeting is available on the meeting website (www.csgmeeting.com.br).

Registration: Participants can register online or by faxing a completed registration form to the meeting organisers (see www.csgmeeting.com.br/?var=how_to_participate).

CSG Auction: It has become standard practice at CSG working meetings to hold an auction to raise funds for specific conservation projects [eg Australia (2004) - *Tomistoma schlegelii* and Tomistoma Task Force; France (2006) - support of first West Africa regional meeting; Bolivia (2008) - telemetry study of Gharial (*Gavialis gangeticus*) in lower Chambal River, India]. Participants are ask to bring a small gift (alcohol, jewellery, books, posters, paintings, products, etc.) that can be auctioned during the farewell dinner.

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

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