

CROCODILES



**Proceedings of the 21st Working Meeting of the
Crocodile Specialist Group
Manila, Philippines, 22-25 May 2012**

(Unreviewed)

2012

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**Proceedings of the
21st Working Meeting of the Crocodile Specialist Group
of the Species Survival Commission of the IUCN
convened at Manila, Philippines, 22-25 May 2012**



Dedicated to the late Charles “Andy” Ross (1953-2011)

(Unreviewed)

International Union for Conservation of Nature (IUCN)
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Front cover: Philippine Crocodile, *Crocodylus mindorensis*. © Crocodylus Porosus Philippines Inc.

Inner front cover: Charles “Andy” Ross. © Tom Dacey

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Table of Contents

Foreword	6
Summary of the Meeting	8
Hosts, Sponsors and Donors	10
List of Participants	11
Life and Work of Andy Ross	
Ross, F.D. How C. Andy Ross got into crocodiles, and some Fuchs content	19
Ross, F.D. C. Andy Ross papers, crocodile scales and Angel Alcala	31
Research and Conservation Efforts on Crocodiles in the Philippines	
Lim, T.M.S. National scenario of the crocodile conservation in the Philippines	49
Van Weerd, M., Balbas, M., van de Ven, W., Rodriguez, D., Telan, S., Guerrero, J., Jose, E., Macadangdang, A., Calapoto, W., van der Ploeg, J., Cureg, M., Araño, R. and Antolin, A. Philippine Crocodile conservation in NE Luzon: An update and a proposal for a National Philippine Crocodile Reintroduction Strategy	49
Manolo, R.I., Belo, W.T., Mercado, V.P., Solco, B.O. and Biñan, Jr. A.J. Distribution and status of crocodiles in Agusan Marsh, Eastern Mindanao, Philippines	50
Conservation Issues	
Hedegaard, R. Establishing a European support program for Philippine Crocodile recovery	58
Cureg, M.C., Van Weerd, M., Balbas, M.G. and Van der Ploeg, J. Environmental education mobilizes community support for Philippine Crocodile conservation: something to be proud of!.....	58
Pul, N., Van der Ploeg, J., Balbas, M., Macadangdang, A., Persoon, G., Cureg, M.C. and Van Weerd, M. Using participatory video filming to engage people in the conservation of the Philippine Crocodile	59
Phothitay, C. and Hallam, C. Status of Siamese Crocodiles (<i>Crocodylus siamensis</i>) in Lao PDR	64
Hallam, C.D., Thongsavath, P., Outhanekone, P. and Platt, S.G. Community-based crocodile conservation for Siamese Crocodiles in Lao PDR	64
Castro, A., Merchán, M., Garcés, M., Cárdenas, M. and Gómez, F. New data on the conservation status of the Orinoco Crocodile (<i>Crocodylus intermedius</i>) in Colombia	65
Fukuda, Y., Webb, G., Manolis, C., Delaney, R., Letnic, M., Lindner, G. and Whitehead, P. Recovery of Saltwater Crocodiles (<i>Crocodylus porosus</i>) following unregulated hunting in tidal rivers of the Northern Territory of Australia	74
Larriera, A., Siroski, P., Piña, C. and Imhof, A. Ranching of <i>Caiman latirostris</i> and <i>Caiman yacare</i> in Argentina: where a problem becomes a livelihood	89
Botero-Arias, R., Marmontel, M. and Filho, S.S. The illegal use of caimans as bait for fishing of Piracatinga, <i>Calophysys macropterus</i> , in the Middle Solimoes River, Brazil	94
Human-Crocodile Conflict	
Elorde, E.G. Rescue of the world's largest crocodile: an effort of local Government Unit of Bunawan to address human-crocodile coexistence	94
Britton, A.R.C., Whitaker, R. and Whitaker, N. Lolong and other dragons: maximum size in crocodilians	95
Campbell, H., Dwyer, R.G. and Franklin, C.E. The behaviour of <i>Crocodylus porosus</i> around an area of high human visitation	100
Rodriguez, D., Van Weerd, M., Van der Ploeg, J., Van de Ven, W., Telan, S., Balbas, M. and Guerrero, J. People's attitudes towards the reintroduction of the Philippine Crocodile in Dicitian Lake	105
Sideleau, B. and Britton, A. A preliminary analysis of worldwide crocodilian attacks	111
Conservation and Management	
Nair, T., Thorbjarnarson, J.B., Aust, P. and Krishnaswamy, J. Identifying individual Gharials to estimate population size, and determinants of habitat use in the Chambal River, India	115
Malla, S., Pradhan, N.M.B., Gurung, G.S. and Khadka, B.B. Gharial conservation initiatives in Nepal	124
Pine, A.K. A newly founded non-profit organisation focused on contributing towards the better understanding and conservation of Tomistoma (<i>Tomistoma schlegelii</i>)	135
Else, R. and Kinler, N. The management of American Alligators in Louisiana, USA: a history, review and update	136
Fukuda, Y., Saalfeld, K., Easton, B., Webb, G., Manolis, C. and Brien, M. Crocodile management and research in the Northern Territory of Australia, 2008-2011	149

Pearcy, A. Assessing crocodile conservation potential in unprotected, rural South Africa	158
Boede, E. The extinction of the Orinoco Crocodile in the Guárico River, Venezuela	162
Montero-Bolanos, J. American Crocodile (<i>Crocodylus acutus</i>) (Crocodylia: Crocodylidae) (Cuvier 1807); population status in the Great Tempisque Wetland	167
Ulloa Delgado, G.A. and Sierra Díaz, C.L. Conservation of <i>Crocodylus acutus</i> by local communities in the mangroves of Cispata Bay, Cordoba, Colombia, South America	179
Ulloa Delgado, G.A. and Peláez Montes, J.M. Preliminary Management plan for the conservation of populations of Caiman Aguja (<i>Crocodylus acutus</i> , Cuvier 1807) at Sardinata, San Miguel, New President and Tibu Rivers, Norte de Santander, Colombia	179
Benitez Diez, H. Monitoring program of Morelet's Crocodile (<i>Crocodylus moreletii</i>) Mexico-Belize- Guatemala	180
Botero-Arias, R. and Marioni, B. Criteria and basis for implementing a management system of Brazilian Amazonian caimans	180
Kula, V. and Solmu, G. Update on wild crocodile population nesting trends in Papua New Guinea (1981-2012) ..	181
Britton, A.R.C. Harvesting of wild crocodile eggs in Queensland by Aboriginal owners	187
Evolution and Systematics	
Velasco, A. Crocodile head and skin photographs vectorized	188
Shirley, M.H. Shedding light on the heart of darkness - comparative phylogeography clarifies taxonomic uncertainty in African crocodiles	192
Gross, B., Venegas-Anaya, M., Weaver, J.P., Bashyal, A. and Densmore III, L.D. Detecting American and Morelet's Crocodile introgressive hybridization using a large number of microsatellites	193
Hinlo, R.P. Population genetics and conservation of the Philippine Crocodile	196
Lopez Gonzalez, E. , Latorre, M.A., Poletta, G.L. and Siroski, P.A. Evaluation of genotoxicity in <i>Caiman</i> <i>latirostris</i> hatchlings exposed <i>in vivo</i> to Roundup (glyphosate), using the Micronucleus Test	197
Amavet, P.S., Vilardi, J.C., Rueda, E.C., Larriera, A. and Saidman, B.O. Mating system and population genetics analysis of the Broad-snouted Caiman (<i>Caiman latirostris</i>)	200
Natural History	
Burtner, B. Symbiosis between long legged wading birds (Ciconiiformes) and alligators (<i>Alligator</i> <i>mississippiensis</i>)? Testing the 'Nest Protector' hypothesis	200
Brien, M.L., Webb, G.J., Lang, J.W., McGuiness, K.A. and Christian, K.A. Born to be Bad: Agonistic conflict in hatchling Saltwater Crocodiles (<i>Crocodylus porosus</i>)	201
Merchant, M., Darville, L. and Murray, K. Isolation and characterization of antimicrobial peptides from the leukocytes of the American Alligator (<i>Alligator mississippiensis</i>)	201
Tellez, M. Host-parasite interaction of the Order Crocodylia	202
Mazzotti, F.J., Jeffrey, B.M., Cherkiss, M.S., Brandt, L.A., Hart, K.M. and Fujisaki, I. The role of American Alligator (<i>Alligator mississippiensis</i>) and American Crocodile (<i>Crocodylus acutus</i>) as indicators of ecological change in Everglades National Park	204
Martelli, P. Ultrasound, a powerful tool for health assessment in crocodilians	205
Nifong, J. and Silliman, B.R. Using critter-cams to compare prey capture and success rates of American Alligators (<i>Alligator mississippiensis</i>) from two Florida estuaries	205
Merchant, M. Assessment of nest attendance of the American Alligator (<i>Alligator mississippiensis</i>) using a modified motion-sensitive camera trap	205
Lance, V.A., Elsey, R.M. and Trosclair III, P. Sexual maturity in male American Alligators in southwest Louisiana	206
Crocodile Husbandry	
Van de Ven, W. Head-starting as a tool for crocodile conservation	206
Fernández, L. Natural and artificial light influence on Broad-snouted Caiman (<i>Caiman latirostris</i>)	207
McClure, G. Deficiencies of crocodilian husbandry in large head-starting facilities and a proposal for an alternative concept	210
Schmidt, F. Research influences a conservation breeding program - the European Studbook for African Dwarf Crocodiles (<i>Osteolaemus tetraspis</i>)	216
Posters	
Solmu, G.C., Plummer, M. and Wana, J. Community Conservation Initiative by the Sepik Wetland Management Initiative	216
Tellez, M., Ramsawamy, D. and Sarimiento, N. Gastric nematode community of <i>Crocodylus acutus</i> , <i>Crocodylus</i> <i>moreletii</i> and <i>Caiman crocodilus chiapsius</i> from southern Mexico	217

Latorre, M.A., López González, E.C., Poletta, G.L. and Siroski, P.A. Effects of <i>in vivo</i> exposure to Roundup® on the immune system of <i>Caiman latirostris</i>	218
Koopmans, F., van Weerd, M., Rodriguez, D., Heitkönig, I., van de Ven, W., Gatan Balbas, M., Macadangdang, A. and van der Ploeg, J. Philippine Crocodile attacks on livestock: implications for conservation	221
Evans, L., Rampangajouw, M., Dausip, J., Saimin, S. and Goossens, B. Human-wildlife conflict: increasing understanding through satellite tracking, education, and resource management	228
Piña, C.I., Simoncini, M.S., Parachú Marcó, M.V., Portelinha, T.C., Cundé, M.C., Hernández, R., Leal, C. and Mora, C. Caiman surveys in Corrientes Province, Argentina	228
Fernández, M.S., Larriera, A. and Simoncini, M.S. Soft and Hard-shelled eggs of <i>Caiman latirostris</i>	229
Portelinha, T.C.G., Verdade, L.M. and Piña, C.I. Detectability of <i>Caiman latirostris</i> (Crocodylia, Alligatoridae) during night count surveys in Argentina	229
Martelli, P. and Cheung, M. Distribution of tissue enzymes in <i>Crocodylus porosus</i>	230
Martelli, P., Tse, L. and Cheung, M. Effect of venipuncture site on hematologic and serum biochemical parameters in the Chinese Alligator <i>Alligator sinensis</i>	230
Ciocan, H., Imhof, A. and Larriera, A. Delayed hatching moment on <i>Caiman latirostris</i> under experimental conditions	231
Leiva, L.A., Bierig, P.L., Imhof, A. and Larriera, A. Usefulness of homemade camera traps for recording activity patterns in <i>Caiman latirostris</i> nesting areas	231
Mazzotti, F.J., Wilson, B., Cherkiss, M.S., Beauchamp, J., Wasilewski, J. and Jeffrey, B.M. Status and conservation of the American Crocodile in Jamaica	232
Cherkiss, M.S., Mazzotti, M.J., Jeffrey, B.M., Beauchamp, J., Hart, K.M. and Larivee, E.J. Spatial ecology of the American Alligator (<i>Alligator mississippiensis</i>) and American Crocodile (<i>Crocodylus acutus</i>) in estuarine areas of Everglades National Park	239
Gelabert, C., Siroski, P., Parachú Marcó, M.V. and González, O. Development of a conceptual model based on the Soft Systems Methodology for evaluating sustainability of <i>Caiman latirostris</i> and <i>Caiman yacare</i> production in Argentina	239
Poletta, G.L., Kleinsorge, E.C., Siroski, P.A. and Mudry, M.D. Oxidative stress and antioxidant defense capacity markers to be applied in <i>Caiman latirostris</i> blood	240
Parachú Marcó, M.V., Merchant, M.E., Siroski, P.A. and Piña, C.I. Red Fire Ant (<i>Solenopsis invicta</i>) venom effects on physiological responses and survivorship in <i>Alligator mississippiensis</i> hatchlings	241
Siroski, P.A., Poletta, G.L., Parachú Marcó, M.V., Ortega, H.H. and Merchant, M.E. Detection and characterization of chitotriosidase enzyme in <i>Caiman latirostris</i> plasma	245
Haghighi, A., Lavihim, M., Puertollano, A., Uyan, J. and Tellez, M. Pentastomid community structure of <i>Sebekia mississippiensis</i> in the American Alligator, <i>Alligator mississippiensis</i>	248
Working Group Reports	
Crocodylian Capacity-Building Manual	249
Veterinary Science	249
Human-Crocodile Conflict	251
Industry	252
Tomistoma Task Force	253
Siamese Crocodile	254
Jamaican Crocodile Conservation	255

The Crocodile Specialist Group

The Crocodile Specialist Group (CSG) is a worldwide network of biologists, wildlife managers, Government officials, independent researchers, non-government organization representatives, farmers, traders, tanners, manufacturers and private companies actively involved in the conservation, management and sustainable use of crocodilians (crocodiles, alligators, caimans and gharials). The CSG is supported financially through the International Association of Crocodile Specialists Inc. (IACS), and operates under the auspices of the Species Survival Commission (SSC) of the IUCN. The CSG members in their own right are an international network of experts with the skills needed to assess conservation priorities, develop plans for research and conservation, conduct surveys, estimate populations, provide technical information and training, and to draft conservation programs and policies. The CSG itself keeps its members updated on international events with crocodilians, conducts reviews of country programs, and tries to track and prioritise issues in forums such as CITES that encourage legal trade and discourage illegal trade. CSG Working Meetings are generally held every two years.

Foreword

The 21st Working Meeting of the IUCN-SSC Crocodile Specialist Group (CSG) was held in Manila, Philippines, on 22-25 May 2010. It was attended by 176 participants from 29 countries. The biennial CSG Working Meetings, which have been held over the last four decades, are fora in which crocodilian conservation action around the world is both initiated and assessed. This meeting, hosted by the Philippines, was both successful and illuminating.

Following the Crocodile Forum held in the Philippines in 2007, Government, industry and NGOs have worked closely together on active conservation programs for the two crocodilian species that occur in the Philippines, the Saltwater Crocodile (*Crocodylus porosus*) and the endemic Philippine Crocodile (*C. mindorensis*).

The CSG is extremely grateful to Crocodylus Porosus Philippines Inc. (CPPI), the Protected Areas and Wildlife Bureau (PAWB) and the National Museum of the Philippines (NMP), who together hosted the meeting. The Organizing Committee consisted of representatives of all three host organisations, under the leadership of Vicente P. Mercado, President of CPPI. The meeting would not have been possible without the generous financial support provided by these key sponsors.

A highlight of the meeting was the attendance by Michel Lacoste, Chairman of the Board of the French corporation Lacoste, and Bernhard Limal and Antoine Cadi, from the French NGO Fonds de Dotation pour la Biodiversité (FDB). As part of the “Save Our Logo” initiative, Lacoste, with assistance from FDB, is already supporting five separate conservation projects on crocodilians around the world. A remarkable corporate achievement.

The Working Meeting was preceded by a meeting of the CSG Executive Committee (20 May), and a meeting of the CSG Steering Committee (21 May), which as usual, was open to all participants. The Steering Committee addressed a wide range of current CSG issues and priorities, particularly in Madagascar, Malawi, Colombia and Indonesia (Lake Mesangat, East Kalimantan). The development of a crocodilian capacity building manual, development of best management practices for crocodile farming, standards for keeping crocodiles in zoos, and renewal of the CSG membership, were all issues discussed.

Lake Mesangat in East Kalimantan, the last remaining habitat for Siamese Crocodiles in Indonesia, was discussed in depth. The spread of oil palms into the immediate lake area was a matter of great concern until a private company (PT REA Kaltim) initiated conservation action. The CSG will send a high level delegation to East Kalimantan to meet with representatives of the regional government and industry about the long-term conservation of this unique site. The CSG completed a morphometric study of caimans in Colombia, which provides the quantitative tools for predicting the size of caiman from which skins and leather products have been derived. The goal was to assist Colombia and the Parties to CITES in their efforts to ensure compliance with Colombia's size limits.

For the many people who work on crocodilians around the world, the CSG working meetings are an important event. Working with crocodilians requires a special effort by special people. Crocodilians live in remote and inhospitable places, where access is difficult. Because they range in weight from less than 50 g to over 1000 kg, catching and handling them is always a challenge - not to mention the personal risks involved. In the eyes of the general public, it is often a thankless task, because crocodiles are truly viewed as being “wicked” by most people. Not so amongst CSG members. The CSG Student Research Award Scheme was established in 2009 to encourage students to work on crocodilians: some 50 students around the world have now benefited from the scheme. We see them as tomorrow's crocodilian conservation champions, and future members of the CSG.

CSG Working Meetings, bring together an exceptional array of talented people, from all around the world. For most of them, the time and travel involved is a significant personal cost. The major reward is the ability to share one week with like-minded people, equally passionate about crocodilians. It recharges often tired batteries, stimulates interest, fosters camaraderie, creates new friendships, puts new faces to names, provides a genuinely sympathetic ears for discussion of problems, and most important, provides an opportunity to pass on new results and findings.

The core business of CSG is to help the IUCN and SSC achieve their conservation missions with crocodilians. This involves a raft of different CSG initiatives and activities in different countries, some simple others immensely complex. They are all addressed openly within the Working Meetings. As the complexity of the world expands, so the “biopolitics” of crocodilian conservation becomes more challenging. But the CSG adapts well. We do an exceptional job, usually quickly, and always honestly, transparently and by consensus. That we do it largely as volunteers, with very few paid staff, is remarkable in its own right.

An important key to the success of the CSG is that its membership includes representation from a great diversity of different stakeholders. We can look at the same problem through many different eyes. Particularly important are members representing the international crocodile leather industry. They keep us focused on attainable goals, make sure our concerns about trade in particular species from specific countries are valid, and offer sound advice and a wealth of experience when required.

The Proceedings of the 21st Working Meeting of the CSG will once again be a unique compendium of current information on research problems in crocodilian conservation, management and sustainable use, and the innovative approaches being taken to solve them. It will serve as an important reference source for CSG members and non-members with an interest in crocodilians. We take this opportunity to thank the organizing committee for their efforts in getting the Proceedings published in a timely fashion.

Summary of the Meeting

The 21st Working Meeting of the IUCN-SSC Crocodile Specialist Group (CSG) was held in Manila, Philippines, 22-25 May 2012, and was preceded by a CSG Executive Committee meeting on 20 May, and full Steering Committee meeting on 21 May. The meeting was hosted Crocodylus Porosus Philippines Inc., the National Museum of the Philippines and the Protected Areas and Wildlife Bureau of the Department of the Environment and Natural Resources.

The Organizing Committee consisted of Daniel Barlis, Careen Belo-Solco, Rainer Manalo, Vicente Mercado, Chona Mercado, Benedict Solco, Theresa Mundita S. Lim, Josefina de Leon, Nermalie Lita, Jeremy Barns, Eloy Cercado, Arvin Diesmos, and Ana Labrador. Together with their support staff, they did a marvellous job in preparing and running the meeting.

None of this would have been possible without the generous financial support provided by the major sponsors: Crocodile Porosus Philippines Inc., the National Museum of the Philippines, and the Protected Areas and Wildlife Bureau of the Department of Environment and Natural Resources.

CSG Chairman Professor Grahame Webb welcomed 176 participants from 29 countries to the meeting (Australia, Argentina, Brazil, Cambodia, Czech Republic, Colombia, Denmark, France, Germany, Hong Kong, Hungary, India, Italy, Japan, Laos, Malaysia, Mexico, Nepal, Netherlands, Papua New Guinea, Philippines, Slovakia, Singapore, South Africa, Sri Lanka, Thailand, United Kingdom, USA, Venezuela). CSG working meetings are normally held each two years, and are the primary international meeting dedicated to crocodilian conservation, management and research. They have become the major forum for discussion of conservation issues involving crocodilians, and for presenting new findings and new directions with research and management. The 21st Working Meeting was no exception, with some truly exceptional presentations.

A highlight of the meeting was the attendance by Michel Lacoste, Chairman of the Board of the French corporation Lacoste, and Bernhard Limal and Antoine Cadi, from the French NGO Fonds de Dotation pour la Biodiversité (FDB). As part of the “Save Our Logo” initiative, Lacoste, with assistance from FDB, is already supporting five separate conservation projects on crocodilians around the world, including a project on Philippine Crocodiles in northern Luzon, operated by the Mabuwaya Foundation Inc.

A number of important issues were addressed by the CSG Steering Committee prior to the working meeting, including the proposed protection of Lake Mesangat in East Kalimantan (Indonesia), the status of the trade ban on *C. niloticus* from Madagascar, Malawi’s export quota, review of Steering Committee appointments and the proposed review of CSG membership following the IUCN World Conservation Congress in September 2012. Important initiatives such as crocodile conservation in Jamaica, outcomes from the CSG meeting on *C. siamensis* held in Bangkok, review of Red List assessments, establishment of a CSG Community Education Group, and the proposed Crocodilian Capacity-Building Manual were also advanced.

A range of topics were covered during the 4-day working meeting, with oral presentations organized into discrete sessions: Management Programs; Populations; Genetics; Disease; Human Dimension; Markets; Conservation; Reproductive Biology; General Biology; and, Physiology. A Poster session also saw a diverse range of topics being covered.

Progress being made with the conservation of the Philippine Crocodile (*Crocodylus mindorensis*), one of the world’s most critically endangered species, was covered by various presentations, and included issues such as hybridization, reintroduction, community education, distribution and status. The two main foci of this work are in northern Luzon and Mindanao. The late Andy Ross (1953-2011), who inspired and mentored much of the work now being undertaken in the Philippines, was honoured through a special presentation given by Vic Mercado, with additional testimonials by Grahame Webb, Tom Dacey, Perran Ross and Charlie Manolis. The late Jack Cox (1952-2010), who collaborated with Andy Ross, and who contributed significantly to crocodile conservation in the Asian region, was also honoured.

Working groups were established for the CSG’s Veterinary Science, Tomistoma Task Force, Industry and Human-Crocodile Conflict thematic groups, and deliberations are summarised in the Proceedings. The Crocodilian Capacity-Building Manual working group established in 2010 was re-convened to progress this issue. Representatives of most Range States for the Siamese Crocodile (*Crocodylus siamensis*), together with researchers and industry members, met during the course of the meeting, and they have proposed the establishment of a Siamese Crocodile Task Force to facilitate and improve communication, and advance common goals with the conservation and management of this critically endangered species.

No CSG meeting would be complete without social activities. The French cuisine lunch hosted by Michele Lacoste on Tuesday, and the welcome function on Tuesday night hosted by Protected Areas Wildlife Bureau were enjoyed by all. The Wednesday night function featuring entertainment by the Bayanihan Dance Troup, hosted by Crocodylus Porosus Philippines Inc., was another great success. The closing ceremony banquet on Friday night, with the CSG Auction, provided a fitting end to a great meeting.

The auction once again proved popular, with auctioneer Joe Wasilewski and his team working at a furious pace. The record sum of \$US5140 was raised, which will go to crocodile conservation efforts in Benin, West Africa. Thanks are extended to all those people who contributed items to the auction, and of course to those who dug deep into their pockets to buy them.

After considerable deliberation, Matthew Shirley (USA) was awarded the Castillos Award for his contribution to crocodilian biology, management and conservation in West and Central Africa.

Following the meeting, participants had the opportunity to go on tours to the many tourist venues around the Philippines, including visiting “Lolong”, the largest Saltwater Crocodile (*Crocodylus porosus*) in captivity in the world (6.17 m long), which was captured in Mindanao in 2011.

Host, Sponsors and Donors

Primary Sponsors:

- Crocodile Porosus Philippines, Inc. (CPPI)
- National Museum of the Philippines (NMP)
- Protected Areas and Wildlife Bureau (PAWB)

Secondary Sponsors:

- Afro-Asia Travel and Tours, Inc.
- Avilon Zoo/Ark Avilon Zoo
- Department of Tourism
- Lacoste
- Mirolabs/JK Mecardo and Sons
- Ocean Adventure
- Oihi/Liwayway Marketing, Inc.
- Tanduay Distillers, Inc.
- Tourism Infrastructure and Enterprise Zone Authority
- Wilco Builders' Depot/Coral Agri-Venture Farms, Inc.

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- Donella Tan (NMP)
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Our thanks also go to:

- the two special artists, Beth Parrocha-Doctolero and Leonardo Onia Jr., who designed the crocodile-on-the-globe motif and the colourful crocodile featured on the souvenir program;
- Golden Acres Farm Inc. for the snacks provided each day;
- Michel Lacoste for sponsoring the French Lunch on 22 May 2012; and,
- The Department of Tourism for providing the Bayanihan Dance Troupe who entertained us at the special dinner on 23 May 2012.

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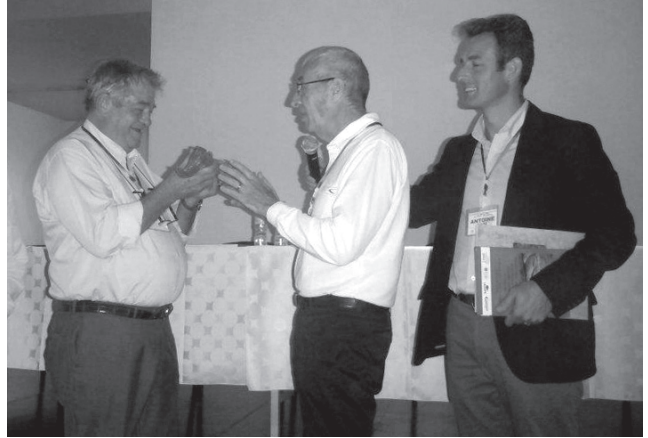
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Michel Lacoste (centre), presents Grahame Webb (left) with a crystal crocodile, as Antoine Cadi (right) looks on.



Allan "Woody" Woodward and Yosapong Temsiripong



CSG Executive



Auctioneer Joe Wasilewski and Alvaro Velasco



Val Lance and wife Kathleen Durning



Matt Plummer, Charles Caraguel, Mark Merchant and Jerome Caraguel



Vic Mercado and Daniel Barlis



Grahame and Freddy Webb with Matt Shirley, winner of the Castillo Award



Marissa Tellez and Ali Haghighi



John Caldwell, Dietrich Jelden and Beatrice Langevin



Anslem de Silva, Abdul Hamid Ahmad, Rambli bin Ahmad and Imran Mohamed Mossadique



Robert Pahl and Merlijn van Weerd



Rene and Nina Hedegaard, with daughter.



Heng Sovannara and Nam Luon



Dietrich Jelden and Ashley Pearcy

How C. Andy Ross got into Crocodiles, and Some Fuchs Content

Franklin Donald Ross

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Abstract

This eulogy about the life and work of Charles Andrew (Andy) Ross features his friendship with Karlheinz Fuchs, and details the history of what can be collectively called “the Fuchs subspecies” (1971 and 1974), including direct quotation of the African crocodiles section in an obscure Fuchs book about leather processing. It is concluded that the new Hekkala *et al.* (2011) model involving a cryptic second species of Nile Crocodile requires “Nilekroko-Cryptic” to be added to the Nilekroko names for hypothesis testing, and further that if *Crocodylus cataphractus* became *Mecistops cataphractus* it could help science by simplifying scholarship about African crocodilians.

Introduction

Charles Andrew (Andy) Ross (1953-2011) was the youngest of three brothers born to Donald and Harriet Ross - Franklin (Frank) is the oldest, followed by Bill. Before she married our father, our mother had been a volunteer helper at the American Museum of Natural History (AMNH) in New York City, and while there (Vertebrate Zoology) had worked with reptiles and amphibians enough that later when I began bringing snakes home, she smiled. Thus, Andy spent his early life in a house where his oldest brother kept snakes, lizards and turtles, and enjoyed catching salamanders and frogs, and was reading about herpetology and eventually teaching amphibian and reptile studies at the Massachusetts Audubon Society. Later, while in college, I got seriously into crocodiles, a subject which also fascinated Andy. Thus, at about the time that Andy was graduating from high school (and had not yet decided what to do with his life), it was on purpose that I gave him two live American Alligators, and suggested that he should volunteer at the Smithsonian Institution in Washington, D.C., and explicitly that he should offer his services to Dr. James (Jim) A. Peters, Curator of Amphibians and Reptiles at the US National Natural History Museum. To his credit, Andy took my advice, and did it.

My mentor in Massachusetts was Dr. Ernest Edward Williams, Agassiz Professor of Vertebrate Zoology and Curator of Reptiles and Amphibians at the Museum of Comparative Zoology, Harvard University. Professor Williams once told me that crocodiles were not yet understood, and had suggested that I should work on them. Thus, ever since I was a teenager, Professor Williams arranged for me to have the keys to the museum’s outside door and to the Herpetology Department, and a document allowing me to work there at night and on weekends.

By the time I gave Andy the two pet alligators, I was employed by the Royal Ontario Museum (Toronto, Ontario, Canada), in the Department of Vertebrate Paleontology, the curator of which had done his Ph.D. at Harvard, on tooth replacement in crocodiles. My studies from the Harvard collection and library continued in Canada, and when photocopy became available, I began making xeroxes of the crocodilian literature. While at the Royal Ontario Museum, I wrote the appropriate letters and then drove by car to New York to examine the AMNH collection, and to Washington to see what the Smithsonian had for the living crocodiles.

The US National Museum’s “dry” crocodiles were stored in a collection of big boxes of drawers, and the tops of the boxes were available at table height to place the specimens for examination. The “wet” crocodiles were in an adjacent room on shelves, and it was easy to bring the wet and the dry material together for comparison. Further, the herpetology library was inside the department, and there was a coffee machine in the Division library, and people sitting around a great big table, many smoking cigarettes. Because of the floor plan, the whole herpetology department walked past the crocodile boxes every time they entered or exited the Division, so working on crocodiles was a social occupation. Every day, Monday to Friday, Dr. Jim Peters led the Division and its visitors to lunch together, and then on their way back, the herpetology staff would stop at the museum’s big library to check the new magazines for the purpose of writing reprint requests for the Division’s library.

Jim Peters was truly an extra dynamic and personable man, and every Friday night he drank beer and enjoyed much congenial laughter with a group of his fellow Smithsonian Natural History curators (his best friend was in Fishes), and because Dr. Peters was the kind of guy that he was, I was invited along on several Friday early evenings after work. Thus, brother Andy volunteered his services to Jim Peters, he was Franklin’s little brother, and now the owner of two alligators that were living in his mother’s bathtub. Further, because of the divorce of our parents, Andy was guaranteed free room and food in Washington at his mother’s house until he was 21 years old. So Jim Peters didn’t have to pay him very much, and hired Andy and put him to work on a project immediately. It was pure coincidence that Jim Peters needed what he called

an intelligent ignoramus, meaning someone bright and enthusiastic and yet virgin to the field. The task was proofing the keys in Neotropical Squamata, while knowing only the definitions of characters from the book itself.

The saddest time that I can remember sharing with Andy was while the two of us were alone in Tuxtla Gutierrez, Chiapas, Mexico, and learned of the death of Jim Peters. We were at that time doing the fieldwork for a future paper (Ross and Ross 1974) about the caudal scalation of Central American *Crocodylus*. Like Andy would later, Jim Peters died of illness in a hospital bed in the company of his immediate family, and like Andy, Jim Peters died long before retirement age. Thus, when Andy was “orphaned” at the Smithsonian, it was Dr. George R. Zug who saved the day by not only assuming the vacant curatorship from within, but also by keeping Andy on staff, and assuming the Smithsonian mentorship of the “Charles Andrew Ross” who eventually went to New Guinea, and visited the Philippines and became extremely close friends with Dr. Angel Alcalá, and through their combined efforts the Ross and Alcalá team essentially single-handedly saved *Crocodylus mindorensis*, from extinction.

The wise and benevolent actions by Jim Peters and George Zug (who later became Chairman of Vertebrate Zoology at the USNM) made a really big contribution to Andy, and in more than just crocodiles, because part of the time Dr. Zug had him working in the Division of Birds (making skeletons), and later marine mammals. Further, Andy has done expeditions on lizards with Dr. James D. Lazell of The Conservation Agency in Rhode Island, USA, and with Riosuke Aoki from Japan. These were decades of Andy being a globetrotter, attending many CSG meetings, and doing fieldwork in India (crocodiles including the Gharial) and the island of Borneo (crocodiles including *Tomistoma* and *Crocodylus raninus*), and shooting birds on the remote island of New Caledonia.

In the very early 1970s, while still at the Royal Ontario Museum, I completed a manuscript on the New World species of *Crocodylus*, and sent copies to Jim Peters and F. Wayne King. The review from Washington was enthusiastic, but in contrast Dr. King informed me that because I treated *Crocodylus intermedius* as a subspecies of the American crocodile *C. acutus* (as *Crocodylus acutus intermedius*), he would block publication of my paper. The reason that I proposed the trinomial combination for the Orinoco Crocodile was to state a hypothesis in the hope that by doing so it would stimulate someone to falsify it, and I was making the intellectual point that the skull shape in *C. acutus* can be the same as in *C. intermedius* in some cases. There were no descriptions or published photos of the dorsal armor that clearly distinguished the American and Orinoco Crocodiles, and it seemed to me to be in the spirit of science to challenge the recognition of *C. intermedius* as a species, and hopefully stimulate scholarship about the subject, leading to clarity. The Orinoco Crocodile could be regulated by CITES as a subspecies as easily as when listed as a full species. A name is a name, and trinomials count.

At that time Wayne King was working toward CITES, and his reason for blocking my hypothesis was to avoid any controversy about the taxonomic list of crocodilians. It was important to him that the crocodile list should be uncontested at the time of signing CITES into law, and it would be good to keep the list frozen for as long as necessary for the crocodile leather industry to adjust to the new rules, and learn the names of the regulated taxa, and how to identify them. Note that Wayne King (in a letter to me) also argued that the extent of the mandibular symphysis technically separated the two Venezuelan *Crocodylus* from each other, but I say that the supposed distinguishing difference is extremely small (within the range of measurement error), and I still believe that skull shape slightly overlaps between these two taxa, given ontogenetic, geographic, individual and possibly even sexual variation (Ross and Pearcy 2010).

The crocodile list in the very early 1970s was from King and Brazaitis (1971), which was the same as the listing in Wermuth and Mertens (1961). My hypothetical *C. acutus intermedius* was new, and in truth, unnecessary and probably wrong. However, one of the last things that Andy and I discussed on the telephone in 2011 was whether or not *C. intermedius* looks like *C. acutus* (with regard to the dorsal scalation). This remains an unresolved and urgent question for the Crocodile Specialist Group. What are the limits of variation in head shape and scale counts in the Orinoco Crocodile, and how can it be distinguished (as a species or as a subspecies) from the American Crocodile (as a species or as a subspecies)? The geographic and individual variation in *C. acutus* is remarkably large (Ernst *et al.* 1999).

While reviewing the New World *Crocodylus*, in addition to becoming aware of how remarkably little was known about the physical appearance of *C. intermedius*, I had noticed that individual, ontogenetic and geographic variation in head shape and dorsal scale counts made it difficult to distinguish the American crocodile (*C. acutus*) from the Morelet's Crocodile (*C. moreletii*) in Central America. Thus, to test and explore a hypothesis in King and Brazaitis (1971), Andy and I went to Mexico, Belize and Guatemala, catching crocodiles and examining living and preserved collections. We confirmed the presumed overlap in traditional characters, and we also confirmed the new King and Brazaitis (1971) ventral skin character, given new definitions. The Ross and Ross (1974) paper provided CITES with a ventral hide dichotomy that identifies a commercial skin from their region of sympatry as either *C. acutus* or *C. moreletii*. As far as we know, the difference in basicaudal and immediately postcloacal ventral and ventrolateral scalation details works 100% of the time. The whole Morelet's Crocodile was later detailed in Ross (1987).

Back when I gave him the two alligators and the advice that he should volunteer to work for Jim Peters (and George Zug)

at the Smithsonian, Andy was living in the Bronx of New York City, and our grandmother on our father's side had an apartment in Manhattan. Andy often visited the AMNH and the Bronx Zoo, and within a short time became friends with Wayne King and Peter Brazaitis. Thus, at the time when CITES was happening, my brother Andy and I knew that Wayne and Peter were handling the crocodile list, and in our estimation it was in good hands. The crocodile taxonomists in the USA and Canada, and in England as well, all agreed that the two new names from Fuchs (1971) would not be recognized. There were no major taxonomic surprises expected. However, some German crocodile people had different ideas, and by the time that the first CITES guide to regulated crocodilian taxa was published in 1983, there was a new arrangement of two subspecies in *C. cataphractus*, and a new schema of 7 subspecies in *C. niloticus*, and further there were too many "spectacled" caiman names at the subspecies level within the *crocodilus* Linnaeus and *yacare* Daudin complex, as detailed below.

Discussion - Part 1: Two spectacled ("common") cayman names too many

During one of our last ever telephone conversations, I asked Andy if Karlheinz Fuchs would be at the 2012 CSG meeting in Manila, and Andy's response was clear. He did not know if Karlheinz was still alive, but (thanks to his being reminded by me) it instantly became Andy's intention to invite him, and Andy expressed hope that his old friend from Germany would be able to attend the CSG meeting. However, Andy died within the next few weeks of that discussion. The following two essays are my attempt to honor this essentially death bed wish.

Based on King and Burke (1989), and before them Medem (1983), Groombridge (1982), Brazaitis (1973) and possibly also King and Brazaitis (1971), the Mato Grosso and Paraguay false names from Germany in the 1970s are not worthy of recognition. It does not matter if the Mato Grosso and Paraguay names are cited as originating in Fuchs (1971), or alternatively in Fuchs (1974a), nor additionally if it is understood that Fuchs (1974a) included a typographical error that was later corrected in Wermuth and Mertens (1977). All of the various spellings are equally invalid because neither Fuchs (1971) nor Fuchs (1974a) qualify under the rules of zoological nomenclature. The M-name and the P-name both lack type specimens, and neither of them was indicated as a new species-group name in 1971 or 1974. It should have been clearly indicated that the M- and P-names were new subspecies. The two skins of which photographs were published in Fuchs (1974a) were not designated as types until later in Wermuth and Mertens (1977), and thus they do not qualify. All type-specimens must be designated in the original type-description.

Neither Brazaitis (1973) nor Medem (1981) mentioned or recognized either the M-name or the P-name, but both of these taxonomic lists recognized other subspecies. Neither Groombridge (1982) nor Medem (1983) recognized the M- and P-names as valid, but both of these lists, which included subspecies, discussed the two false-names, and in the process they employed the spellings from Wermuth and Mertens (1977), and attributed to Fuchs (1974a), as opposed to Fuchs (1971). More recently, King and Burke (1989) reviewed some of the spelling variations, and distinctly rejected the Mato Grosso and Paraguay names from Fuchs (1971, 1974a) and also the revision of Fuchs (1974a) by Wermuth and Mertens (1977).

When tannery engineer Karlheinz Fuchs added his own two new names to the old and established Wermuth and Mertens (1961) list, he knew remarkably little about the rules and practices of zoological nomenclature. It was probably in 1973 that Fuchs received the advice from Dr. Heinz Wermuth (and possibly Dr. Robert Mertens as well) that the spellings of the Mato Grosso and Paraguay names from 1971 should be changed to become more correct latinizations. The newer spellings in Fuchs (1974a) were obviously an attempt to follow that advice, but apparently included a typographical error. This "error" was replaced by a correction in Wermuth and Mertens (1977), and both the M-name and the P-name spellings from 1977 were recognized by Wermuth and Fuchs (1978, 1983), and more recently by Obst (1996).

Essentially every species-group name recognized in Fuchs (1974) was illustrated with a pair of photographs of a commercial ventral skin of the taxon. One photo shows the normal outside surface, and its mate showed the surface inside the animal. These photos were not intended as the type-specimens of latinized names, but rather as illustrations of leather from the various taxa. There was no locality data in Fuchs (1974a) for any of these individual belly hides, including the pictures in the taxonomic accounts of the Mato Grosso and Paraguay names, which in 1974 were recognizable as being the M- and P-names from Fuchs (1971), but spelled slightly differently. Thus, when Wermuth and Mertens (1977) cited the photographs of belly skins in Fuchs (1974a) as the types of the M- and P-names (revised spellings), it was the origin of the so-called type designations. However, this can not be true, because the type of a name must be designated in the original paper, which Wermuth and Mertens (1977) said was Fuchs (1974a), but I say was Fuchs (1971). The pictures were added in 1974, and they were just ordinary photos until they were later interpreted in 1977 as types.

All of the taxonomic account photos from Fuchs (1974) were reprinted in Wermuth and Fuchs (1983), but the pictures and taxonomic accounts of the Mato Grosso and Paraguay names were deleted in Fuchs (2006). As a generality, none of the taxon photos in Fuchs (1974a, 2006) and Wermuth and Fuchs (1983) are useful for scale counts, partly because the cloaca is usually crudely cut from the skin, and partly because of glare and bending, and the photos are too dark or too light, and too small.

The Mato Grosso and Paraguay names in their 1974 spellings were listed in Index B of the 1995 CITES guide (Charette 1995), but were not illustrated in a taxon account in the 1995 text. This was a compromise, but it implied that the M-name and also the P-name were still recognized and regulated by CITES. Most recently, Trutnau and Sommerlad (2006) discussed the M-word and the P-word by name, but did not recognize either of them as valid. In roughly chronological order, the various spellings of the M- and P-names, and notes about whether or not they were recognized, are presented in List 1 below.

List 1. Sixteen spellings of M- and P-names history examples

1. Wermuth and Mertens (1961): these two names had not yet been invented.
2. Fuchs (1971: 202 [p. 8 reprint]): valid in combination with *Caiman crocodilus*, and thus clearly recognized with the spellings *matogrossoiensis* and *paraguayiensis*.
3. King and Brazaitis (1971): not mentioned [if they knew about Fuchs (1971) yet].
4. Brazaitis (1973): not mentioned, and therefore clearly not recognized as valid.
5. Fuchs (1974a: 66, 70): valid in combination with *Caiman crocodilus*, and recognized as *matogrossiensis* Fuchs and *paraguayensis* Fuchs.
6. Wermuth and Mertens (1977: 137-138): valid in combination with *Caiman crocodilus*, and mentioned as *matogrossoiensis* Fuchs, 1971, but actually recognized with its spelling corrected to *matogrossiensis* Fuchs, 1974, and separately they mentioned *paraguayiensis* Fuchs, 1971, and recognized it as valid with the spelling *paraquaiensis* Fuchs, 1974, which in 1977 they corrected to *paraguayensis* Fuchs.
7. Wermuth and Fuchs (1978: 52-53): valid in combination with *Caiman crocodilus*, and recognized as *matogrossiensis* Fuchs and *paraguayensis* Fuchs.
8. Medem (1981): these two names were neither explicitly mentioned nor discussed in general (they do not occur in Colombia).
9. Groombridge (1982: 287, 303): not recognized as valid, but discussed as *matogrossiensis* (p. 287 typographical error) = *matogrossiensis* (p. 303); and, *paraguayensis* (pp. 287 and 303).
10. Wermuth and Fuchs (1983: both parts): recognized as valid for CITES in combination with *Caiman crocodilus*, and spelled *matogrossiensis* Fuchs, 1974; and, *paraguayensis* Fuchs, 1974 (employing the corrected 1977 spelling).
11. Medem (1983: 24): not valid (clearly rejected), but discussed (see quote in List 2 below) as *matogrossensis* Fuchs, 1974; and, *paraguayensis* Fuchs, 1974.
12. King and Burke (1989: 3, 5-6): not recognized as valid, but in two separate places (*crocodilus* and *yacare*) discussed as *matogrossoiensis* (in 1971) and *matogrossiensis* (in 1974); and, *paraguayiensis* (in 1971) and *paraquaiensis* (in 1974).
13. Charette (1995: Index B): valid for CITES and recognized in combination with *Caiman crocodilus* as *matogrossiensis* and *paraguayensis*.
14. Obst (1996: 450): valid in 1996, and recognized in combination with *Caiman crocodilus* as *matogrossiensis* Fuchs, 1974; and, *paraguayensis* Fuchs, 1974.
15. Trutnau and Sommerlad (2006: 390): not valid in herpetology, but explicitly mentioned in their “Spectacled Caiman” text spelled as *matogrossiensis* and *paraguayensis*, with both tentatively called junior synonyms of *Caiman yacare*, though definitely not appearing in their p. 409 synonymy of their “Yacare Caiman” species.
16. Fuchs (2006): no mention or discussion of these two names.

In addition to lacking type-specimens, Fuchs (1971) was further deficient in lacking any type-locality data. Thus, the M-name and the P-name each had a distribution in 1971, and similarly Fuchs (1974) also later gave a distribution, although in one case he slightly changed the wording, compared with the wording in the 1971 original. The revised 1974 wording of the distributions was later employed by Wermuth and Mertens (1977) as the distributions of the whole individual subspecies taxa, and in 1977 they created a type-locality for the M-name and a separate type-locality for the P-name. Essentially all authors who cite Fuchs (1974a) as the origin of the M- and P-names employ the distributions from Fuchs (1974a) and repeated in Wermuth and Mertens (1977). Similarly, any assertions of type-locality data for the M- and P-names actually originated in Wermuth and Mertens (1977). In approximately chronological order, these sources of geographic assertions are presented in List 2.

List 2. Six localities allegations examples, including F. Medem quote

1. Fuchs (1971: 202-203) [8-9 reprint] said “Mato Grosso-Brillenkaiman” with “Verbreitung: Südbrasilien (Mato Grosso)”; and, separately the “Gran Chaco-Brillenkaiman” with “Verbreitung: Paraguay (Flußsysteme des Rio Paraguay und Parana)”.
2. Fuchs (1974a: 66) said “Mato-Grosso-Krokodilkaiman” with “Verbreitung: Süd-Brasilien (Mato Grosso)”; and, separately (p. 70) “Gran-Chaco-Krokodilkaiman” with “Verbreitung: Paraguay (östlich des Rio Paraguay), Rio Verde, Rio Monte Lindo, Rio Negro, Rio Confuso, Rio Pilcomayo”.
3. Wermuth and Mertens (1977: 137) said for “*Caiman crocodilus matogrossiensis* Fuchs” that in 1971 (spelled

“*matogrossoiensis*”) it had “Patria: Mato Grosso, Brasilien” and in 1974 and 1977 had “Verbreitung: Südliches Brasilien (Mato Grosso)” and new in 1977 “Terra typica: Mato Grosso, Brasilien” was added to Fuchs (1974) in a sneaky fashion; and, separately on page 138 said for “*Caiman crocodilus paraguayensis* Fuchs” that in 1971 (spelled “*paraguayensis* Fuchs”) it had said “Patria: Paraguay”, and in 1974 and 1977 it had “Verbreitung: Paraguay (nordöstlich des Rio Paraguay): Rio Verde, Rio Monte Lindo, Rio Negro, Rio Confuso und Rio Pilcomayo”; and, invented newly in 1977, “Terra typica: Rio Verde, Paraguay” was added in a sneaky fashion to Fuchs (1974).

4. Wermuth and Fuchs (1978: 53) said “Mato-Grosso-Krokodilkaiman” with “Verbreitung: Südliches Brasilien (Staat Mato Grosso)”; and, on page 52 said “Gran-Chaco-Krokodilkaiman” with “Verbreitung: Mittleres Süd-Amerika (Paraguay, östlich des Rio Paraguay: Rio Verde, Rio Monte Lindo, Rio Negro, Rio Confuso, Rio Pilcomayo)”.
5. Wermuth and Fuchs (1983) said “Mato Grosso crocodile caiman, Mato Grosso spectacled caiman, Brazil caiman” with “Distribution: S. Brazil (Mato Grosso)”; and, also in the skins taxon accounts said “Gran Chaco crocodile caiman, Gran Chaco spectacled caiman” with “Distribution: Paraguay (W of the Rio Verde, Rio Monte Lindo, Rio Negro, Rio Confuso, Rio Pilcomayo)”.
6. Medem (1983: 24) said “Las descripciones de *Caiman crocodilus matogrossensis* y *C. c. paraguayensis* como nuevas subespecies son algo extravagantes, en razón a que como holotipos figuran sólo las partes ventrales de pieles exportadas comercialmente: *Caiman crocodilus matogrossensis* Fuchs (1974a: 66; figs. 67-68). Localidad típica: Mato Grosso, Brasil, sin localidad exacta. Este nombre fue repetido por Wermuth y Fuchs (1978: 53; fig. 18e). *Caiman crocodilus paraguayensis* Fuchs (1974: 70; figs. 71-72). Localidades típicas: Los ríos Verde, Monte Lindo, Negro, Confuso y Pilcomayo, situados en el oriente del Paraguay. La designación fue también repetida por Wermuth y Fuchs (1978: 52; fig. 18d). [paragraph break] Comentarios. La designación de una piel comercial como holotipo, junto con la falta de una localidad típica exacta, es inadmisibles según las correspondientes Reglas de la Nomenclatura. El holotipo y los paratipos deben ser designados en base a uno o varios ejemplares enteros, un cráneo, o en casos excepcionales, una piel completa. Por esta razón, la gran mayoría de los herpetólogos profesionales no aceptan la validez de dichas subespecies. [paragraph break] El señor Fuchs, ingeniero químico de Höchst Farbwerke in Frankfurt am Main, especializado en la elaboración de sustancias químicas para preparar y teñir las pieles de la industria alemana de curtiembre, tiene el mérito de haber llamado la atención sobre la importancia de los osteodermos (‘botones’, de la capa interna, osificada de cada escama), en la identificación de las pieles comerciales. Es muy cierto que la configuración, el grado de osificación y el tamaño de estos osteodermos del escamado ventral, o su ausencia parcial o total en varios géneros, constituyen caracteres morfológicos adicionales de gran valor para la taxonomía, siempre y cuando exista un experto capaz de distinguirlos. Para ello hay que estudiar, repetidas veces y durante muchos años, miles de pieles de los Crocodylia procedentes del Sur y Centro América, África, Asia, Australia, Papua-Nueva Guinea y Las Filipinas. Son los únicos expertos de esta índole los señores Fuchs, King, Brazaitis y Wermuth. [paragraph break] *Caiman yacare* es considerado como subespecie de *Caiman crocodilus* por Fuchs (1974) y otros autores, y denominado *Caiman crocodilus yacare*. Desde el punto de vista sistemático, dos subespecies nunca pueden coexistir en una misma región, como sí pueden hacerlo dos especies. En caso dado que las tres subespecies, *C. s. yacare*, *C. s. paraguayensis* y *C. s. matogrossensis* estén confinadas a un mismo hábitat, hay que elevar nuevamente *C. yacare* a su estado específico. [paragraph break] En el primer caso, la simpatria de las diferentes subespecies dentro de un hábitat bien definido, v. gr. el Mato Grosso, es casi imposible; aún si coexistieran dos especies, habría ocurrido una amplia hibridación (ver Perú y Bolivia). Además la presencia de *Caiman sclerops* en el Mato Grosso es dudosa (Leitão de Carvalho, in litt., 1974; ver Brasil). [paragraph break] Finalmente hay que advertir que la procedencia de las pieles exportadas comercialmente es bastante incierta (v. gr. pieles declaradas de Paraguay son oriundas de Bolivia y el Brasil, ver caza comercial).”

In 1974, there was a second Fuchs book published, and this one was from the Food and Agriculture Organization (Rome, Italy) of the United Nations. Whether the FAO book was published before or after his *Die Krokodilhaut* book (Fuchs 1974a) is unclear, because neither of these two 1974 sources have a date printed on them. The classification of the caymans in Fuchs (1974b) was the same as in Wermuth and Mertens (1961), and was notably lacking both the M- and the P-names. Thus, neither Fuchs (1974b) nor Fuchs (2006) recognized the Mato Grosso and Paraguay names from 1971 (or alternatively from Fuchs 1974a) as valid. From circumstantial evidence pertaining to African crocodilian subspecies, it appears that Fuchs (1974b) was written in 1973, and published the following year. The taxonomy in the this book lacks the new African Slender-snouted Crocodile subspecies created in 1974 by Fuchs *et al.* (1974b), and it further lacks the 7 subspecies of Nile Crocodiles schema by Fuchs *et al.* (1974a).

Exactly why the Fuchs (1974b) book titled “Chemistry and Technology of Novelty Leather” did not recognize or even mention the M- and P-names is unclear, but the result was a listing of caiman taxa that agreed with that of Wermuth and Mertens (1961), King and Brazaitis (1971) and Brazaitis (1973). Further, although they had not been published yet, the FAO book (novelty leather) was in agreement with the taxonomy in Groombridge (1982), Medem (1981, 1983) and King and Burke (1989) with regard to the M- and P-names. There has been minor controversy about *yacare* being a subspecies or alternatively a species, and further about *crocodilus* or *sclerops*, but neither *Caiman crocodilus*, *Caiman sclerops* nor *Caiman yacare* have the M-name or the P-name included in them today.

The M- and P-names originated in Fuchs (1971), in the magazine *Das Leder*, published by the German chemical industry

as a monthly serial. In my opinion, Das Leder is not an appropriate magazine for the creation of new scientific names, even if hypothetically they had included the designation of types and were properly annotated as new taxa. If Karlheinz Fuchs had not attended CSG meetings and circulated reprints of his 1971 paper, the nomenclatural world would not have known of the existence of the Das Leder article. The Fuchs (1971) M- and P-names were not only empty, but, additionally, they probably could not become available, due to the publication requirements of the Code. For corroborative notes in the Crocodile Specialist Group Newsletter concerning the Mato Grosso and Paraguay names from K. Fuchs (see Ross 2005d, 2006f).

Regardless of whether they became available at all, and further whether they became available in 1971 or alternatively 1974, the Mato Grosso and Paraguay names became very official in Wermuth and Mertens (1977), and further in Wermuth and Fuchs (1978, 1983). At least some of the credit for this development rests on the shoulders of Karlheinz Fuchs, but Andy and I now agree that whatever happened in Germany when Fuchs joined forces with Mertens and Wermuth, it was probably Heinz Wermuth who really created the 1983 recognition of the M- and P-name problem for CITES. In an e-mail dated 1 August 2006, Andy said to me: “Concerning Karlheinz, he is truly a very nice gentleman and our only remaining link to Heinz Wermuth. If he has done a sloppy job, then the blame rests with Heinz, as he should have known better”.

Discussion Part 2: Dr. Wermuth’s mistake, and K. Fuchs’ lengthy quotation

The major relevance of Karlheinz Fuchs to the CSG, and to the crocodiles of the Philippines, is his series of publications concerning the tanning of commercial reptile leather. Anyone seeking to establish a crocodile skin processing industry will find Fuchs to be a valuable asset, and in addition to his recent essays in Trutnau and Sommerlad (2006), and also his own book (Fuchs 2006), there is an earlier book (1974), as opposed to the Fuchs (1974a) “Die Krokodilhaut” book, which also included information about crocodile leather and its processing. The best source of technical advice is still Fuchs (1974b), but it is a very rare item.

Similarly hard to find in libraries is a Fuchs (1969) paper. On the same subject, Medem (1981) said “Karlheinz Fuchs, representante de la industria de curtiembre en Alemania Federal, nos informó durante el Congreso en Frankfurt am Main en mayo de 1976, que la compañía Farbwerke Höchst AG está perfeccionando nuevos productos químicos que se utilizarán próximamente para ablandar los ‘botones’ (osteodermos) de la piel ventral y así facilitar la curtición (Medem 1977).”

Ross (2005a,c, 2006a-e,g, 2007a) has already detailed some of the problems concerning the African subspecies from Fuchs *et al.* (1974a,b), but I would like to add my consternation concerning the designation of a commercial ventral skin as the holotype of *Crocodylus cataphractus conigicus* (Fuchs *et al.* 1974b). In agreement with Medem (1983), I argue that because commercial belly hides lack their heads and dorsal armor, and lack the whole posterior part of the tail, and often have the cloacal region badly damaged, they are inappropriate as types today. Further, these ventral hides very often have misleading and generally vague locality data. The belly skin on which the species-group name *conigicus* is based apparently came from somewhere in the Congo basin, perhaps shipped from Kisangani (formerly Stanleyville), or perhaps from Kinshasa, or from Brazzaville. The term “Central Congo” is ambiguous, and at best it merely tells us from what major city this raw piece of leather was shipped to Germany.

I have thought long and hard about how to best contribute to science concerning the Fuchs *et al.* (1974a,b) revisions of *C. cataphractus* and *C. niloticus*, and have decided to quote the original Fuchs (1973) treatment of these two African crocodiles. However, the Fuchs (1973) paper is in German. Therefore, it is the Fuchs (1974b) version in English which follows. The information and presentation in Fuchs (1973: 29-32) is essentially the same as in Fuchs (1974b), which for these two species is pages 9-10.

“The Nile Crocodile (Crocodylus niloticus)

“Size: up to seven metres.

“Geographical distribution: Africa south of the Senegal river, Lake Chad and Khartoum; extinct or extremely rare to the north of these regions; ranging southwards down to Cape Town but rare south of the Kunene river, the Kalahari desert and the Tugela river near Durban, Madagascar, the Comoro Islands, the Seychelles. It inhabits fresh-water but also brackish and sea water.

“No other crocodilian species is as notorious as the Nile crocodile. Its size in particular is often widely exaggerated. From parts of skeletons found on Madagascar, a length of about ten metres could be inferred but animals attaining a length of five metres are now quite rare. Depending on its age, the Nile crocodile feeds on insects and vertebrates [(sic) does he mean invertebrates?] but the bulk of its diet consists of fish. Its back skin is generally dark bronze-green with irregular patches, although brownish animals are not rare; the underside has a dirty yellow colour. Professor Dr. F. Stather (Gerbereichemie und Gerbereitechnologie. 4th edition 1971, Akademie-Verlag, Berlin) regards the skin of the Nile crocodile as unsuitable for processing into leather because of the osseous dermal armour which covers the surface

of the entire body. A. Becchino (Richtlinien zur Gebung von Reptilien. Das Leder 3, 1956, pp. 190 & 191) arrives at much the same conclusion since he considers that the osseous dermal skeleton cannot be separated from the corium proper. In fact, the skin of the Nile crocodile is the best-known and most valuable of the classic African Croco skins and is traded under the following names:

“Croco Afrique is the trade name for all crocodile skins from eastern Africa (Burundi, Kenya, Mozambique, Rhodesia, Sudan, Tanganyika, Tanzania). All these skins are very long in relation to their width, the head part is large in area and almost square. The flank scales are oval and arranged in five to six longitudinal rows. Very few osteoderms are embedded in the connective tissue of Croco Afrique, which may be described as a medium-grain type of skin. The caudal part is relatively large in area. The maximum width of the skin is about one point two five metres, the length about four point twenty metres.

“Croco Mada is the commercial description of all crocodile skins of Madagascan origin. These, too, are of the medium-grain type, although the scales are smaller than those of Croco Afrique. The connective tissue of Croco Mada skins is entirely free from osteoderms. The flank scales resemble those of Croco Afrique but are arranged in four or five rows only. A characteristic feature of this type of skin is the double row of broad scales found along each side of the ventro-median line. In the leather trade Croco Afrique and Croco Mada (finished leathers) are often graded together, since the number of skins from Madagascar is very small and the two types of skin resemble one another in scalation.

“Nigeric Non Corré: skins sold under this description are of Nigerian origin and are of the large-grain type. The collar region is slightly ossified in some places, as are the belly scales from the sixth to tenth row of scales counted from the edge of the flanks. However, the bony deposits are not as compact as in Gavial Afrique [*C. cataphractus*] and are therefore hardly noticeable after the grain has been glazed. As far as the tail skin is concerned, the bony deposits occur only along the edge of the first to fourth longitudinal row of caudal scales counted from the anus. The flank scales are arranged in four longitudinal rows and are relatively large. In the case of Croco Nigeric Non Corré the skin trade distinguishes between skins which are only slightly ossified and those which are completely non-ossified.

“Of all the recent crocodilians the Nile crocodile (*C. niloticus*) probably yields the best horn-backs since its dorsals show up most beautifully in the finished leather. [End of p. 9, start of p. 10] The dorsals are arranged in regular longitudinal (six) and transverse (fourteen) rows. Except for those in the two rows nearest to the flanks, they are all rectangular in shape. Those forming the double row down the dorso-median line are never enlarged, as are those of the mugger (*C. palustris*).

“Horn-backs generally allow the species from which the skin is obtained to be identified accurately since the two major distinguishing features, the postoccipitalia and the nuchalia, are still recognizable in the skin material. Figure 26 [which is a mugger, he probably meant fig. 25 which is *C. niloticus*. In fact, both photos are too small and too dark to actually see these scales] shows the postoccipitalia (one row consisting of four oval, keeled osteoderms) and the nuchalia (two rows of prominently keeled osteoderms of which there are four in the first row behind the postoccipitalia and two in the second row).

“The Narrow-Nosed West African Crocodile (Crocodylus cataphractus)

“Size: up to four metres.

“Geographical distribution: western and central Africa (from Senegal south to northern Angola); in eastern Africa encountered only in Lake Tanganyika near Ujiji, it inhabits fresh-water and brackish water. The skin of the narrow-nosed West African crocodile is characterised by extensively ossified anterior ventral shields. Its snout is very long, narrow and pointed, resembling in shape that of the gharial or gavial. Its staple diet consists of fish. Fresh-water lakes are the preferred habitat of this species, which is non-aggressive and fairly harmless to humans. The back is dark olive, the underside yellow with irregular black patches. The skin of the narrow-nosed West African crocodile is traded under the names of ‘Gavial Afrique’ and ‘Nigeric Corré’.

“The Gavial Afrique: Most crocodile skins sold under this name come from the Congo. Their head portion is more pointed and smaller in area than that of Croco Afrique skins. They may be described as being of the large-to-medium-grain type. Throat and collar region are extensively ossified to the gular sac. Massive ossification characterizes the belly skin from the fifth to the twentieth row of ventral shields, while the eleventh and twelfth row are only slightly ossified. The compact connective tissue ossifications are very noticeable also in the finished leather. The tail is fairly extensively ossified from the first to the fifth transverse row and the fifth longitudinal row of scales. The scales on the flanks are non-ossified, oval and arranged in six longitudinal rows.

“The Nigeric Corré: The gular part of this large-to-medium-grain type of skin is less extensively ossified than that of Gavial Afrique but the collar part shows the same degree of ossification. The belly scales are ossified from the fourth to the ninth transverse row counted from the collar, and these ossifications are very noticeable in the grain of the end product. The tail skin shows medium ossification from the first to the sixth or fourth-transverse row of scales. The non-ossified, large, oval flank scales are arranged in four longitudinal rows.”

Also relevant to the CITES list of African crocodilians, Fuchs (1973) and Fuchs (1974b) recognized only one kind of *Osteolaemus*:

“The Broad-Fronted Crocodile (Osteolaemus tetraspis)”

“Size: up to 1.90 metres.

“Geographical distribution: western Africa south of Sahara desert to central Africa (north-east of Zaire). The broad-fronted crocodile is one of the dwarf-crocodilians. Some authors distinguish two species. It feeds on amphibians and fish and also on fruit - an unusual diet for crocodiles. Young animals are yellow-banded but they may also display irregular spots in all shades from yellow to brown. From a length of forty-five centimetres onwards the pale markings disappear, and once the animal has attained a length of fifty centimetres, its skin is almost black even on the underside. The skin of the broad-fronted crocodile is traded under the name ‘Croco Benin’.

“The Croco Benin is a large-grain type of skin. The collar is extensively ossified, as are the belly shields from the sixth to the eleventh row. The tail is completely ossified with the exception of the median line formed by one row of enlarged scales. An unusual feature of Croco Benin is that the ossifications increase considerably towards the tip of [end of p. 10, start p. 11] the tail. The lateral scales vary in size and are arranged in six to eight rows. They are mostly ossified to a varying extent. Croco Benin probably illustrates best the relative lack of pigment in the corium of crocodile skins as compared with lizard skins. The raw skins are blackish brown on the back and flanks; the belly has a cloudy dark brown coloration. After removal of the epidermis in the liming process the belly skin is completely white, while flanks and tail still show a very pale greyish brown pigment. Croco Benin skins are also traded under the name ‘Cabindas’.”

Considering that CITES regulates each country independently, the African taxa in Fuchs (1973, 1974b) as *Crocodylus niloticus*, *Crocodylus cataphractus* and *Osteolaemus tetraspis* would have been entirely sufficient. The trade names of various commercial ventral hides could have remained what they really were: common names in the leather industry, and not formal and latinized subspecies. The difference between the treatment of the African taxa in Fuchs (1973, 1974b), compared with Fuchs (1974a) is very significant, and I strongly suspect that the change was in some substantial way related to the signing of CITES, and the US Endangered Species List before it.

Karlheinz Fuchs is the only person who knows why the *Crocodylus cataphractus congicus* (Fuchs *et al.* 1974b), subspecies was considered needed in 1974. My best guess is that it circularly confirmed the separation of *Osteolaemus tetraspis* into subspecies with the same set of distributions (the *O. t. osborni* population from the Ituri Forest corresponds with the new *congicus* population of African Slender-snouted Crocodiles). Similarly, Fuchs can perhaps explain why Fuchs *et al.* (1974a) recognized 7 subspecies of *Crocodylus niloticus* with resurrected old names. Like changing from coal power to nuclear, it is a quantum leap from Croco Afrique to *Crocodylus niloticus africanus* Laurenti, 1768, because the latter is not necessarily an African crocodile. It is based on a faulty Seba picture from 1734, as explained in Ross (2006a).

Obst (1996) said about the crocodilians that “since 1961 the inventory of forms has expanded by a small number of previously unrecognized subspecies. Many more subspecies that were not yet accepted at that time have since been revalidated, on the basis of extremely painstaking studies of the scale characteristics. Remarkably, the crocodile leather specialists have turned out to be the most reliable authorities here, familiar with even the smallest details!” This hypothesis is still being tested, particularly with the African taxa; but, in contrast the Latin American common and South American broad-snouted caymans have pretty much stayed as they were in Wermuth and Mertens (1961), with *Caiman crocodilus crocodilus*, *Caiman c. apaporiensis*, *Caiman c. fuscus*, *Caiman c. yacare*, and *Caiman latirostris*. The only difference in Fuchs (2006) and Trutnau and Sommerlad (2006) is that *yacare* is recognized as a full species, in agreement with Medem (1983). Note that in List 2 (above), when Medem (1983) said “*C. s. yacare*” he meant *Caiman sclerops yacare*, which is a synonym of *Caiman crocodilus yacare*. For perspective about *yacare* as a scientific name, see Ross (2005b); and, concerning the question of *yacare* as a species or alternatively as a subspecies, see Ross 2005e.

Conclusions. Some thoughts of my own about African “cryptic” species

In his 1 August 2006 e-mail to me, Andy further said: “I very much encourage you to meet with Karlheinz and hopefully collaborate to clean up some of the obvious problems instead of just pointing them out, as this does little good. He speaks fluent English, and I am sure that he would relish the opportunity to talk systematics. You two might get along famously.”

It is approximately four decades since the 7 subspecies of the Nile Crocodile schema was proposed, and one of the taxa, *suchus*, has recently been elevated to a full species, based on DNA evidence. It is no longer possible to set the whole question aside by not recognizing any subspecies, as was done by Ross and Mayer (1983). Rather, as exemplified by Hekkala *et al.* (2011) - “Taking precautionary measures such as recognizing the ancestral lineage as *C. suchus* on the IUCN Red List and reviewing its status, could reduce further loss of at-risk populations.” and “Recent survey efforts indicate that *C. suchus* is declining or extirpated throughout much of its distribution. Without proper recognition of this cryptic species,

current sustainable use-based management policies for the Nile Crocodile may do more harm than good.”), and earlier by Fuchs (2006) and others, there is currently pressure on CITES to regulate *Crocodylus suchus* as a taxon distinct from *C. niloticus*. The data in the new paper by Hekkala *et al.* (2011) suggests to me that tannery engineer Karlheinz Fuchs was possibly correct in Fuchs (1973, 1974b) about Croco Nigeric Non Corré being different from Croco Afrique, and further that Croco Afrique and Croco Mada are generally similar to each other. Concerning recent DNA evidence, and for earlier discussion about cryptic crocodile species in Africa, see Hekkala *et al.* (2010) and Shirley and Eaton (2010).

If I understand Hekkala *et al.* (2011) correctly, the system of Nilekroko hypothetical “taxa” proposed in Ross (2007b,c, 2010) needs to be expanded to now include Nilekroko Cryptic (NK-C), which can be subdivided as NK-C-NileRiver, NK-C-SenegalRiver, NK-C-NigerRiver, NK-C-CongoRiver, and NK-C-IndianOceanDrainages, etc., as needed. The question today appears to be whether Nilekroko-Vulgar wild in the Nile River in Egypt near ancient Thebes was the same species as Nilekroko-Cryptic-NileRiver or not, with it suggested by Hekkala *et al.* (2011) - “That all mummy crocodiles from Thebes [ancient Egypt] and Samoun [ancient Egypt] exhibit the western haplotype suggests both lineages [an eastern clade and a western clade] historically occurred in the lower Nile River. These findings are consistent with early arguments of two *Crocodylus* species in Egypt, including historical accounts that ancient Egyptian priests were cognizant of two forms and selectively used the smaller, more tractable form in temples and ceremonies [Herodotus in Geoffroy Saint-Hilaire 1807]. Analysis of museum specimens from more recent collections provides additional evidence that both lineages were present in the upper Nile in Sudan until as recently as the 1920s.”) that the captive Thebes animals were from the Nile, and were NK-C, which they further suggest is NK-WestAfrica and NK-Pedomorph combined.

If we can set Hekkala *et al.* (2011) and Herodotus and Étienne Geoffroy-Saint-Hilaire aside, I would again, as I did in Ross (2005a), ask why would the ancient Egyptian priests exhibit small and non-aggressive adult crocodiles to the public, when it is easy to train the large and dangerous kind to politely and gently, and one at a time (the crocodiles have their own dominance hierarchy), take food without biting the hand that feeds them. It was surely more impressive to enter an enclosure of really big crocodiles, as compared with an enclosure of small and demure ones. The Thebes “crocodile feeding show” was so impressive that we are still discussing it today. However, the possibility of NK-Cryptic being the Thebes Temple animal remains, because any regionally famous captive crocodile exhibit would have been reported by the ancient European explorers of Egypt.

None of the DNA studies of the living African crocodiles that are *Crocodylus*, as opposed to *Mecistops* and *Osteolaemus*, have counted scales or measured skulls (or at least they have not reported the data yet). In contrast, an attempt to tell us how to identify an individual animal, within limits, utilizing visually or tactilely (bending scales to see if they have bone inside them) determinable external characters, not relying on DNA analysis (which is not available in the field, and always expensive, and often involving the need for CITES permits) has been made by my brother’s friend Karlheinz Fuchs.

One simple thing that the IUCN’s crocodile list for CITES could do, to make scholarship and investigation just a little bit easier, is to recognize the combination *Mecistops cataphractus* (Cuvier, 1824) for the African Slender-snouted Crocodile, and return its type-locality back to “unknown” as it was in 1818 and 1824, and then all the way up to Fuchs *et al.* (1974b). There had been no need to invent a type-locality for the name *Crocodylus cataphractus* Cuvier, 1824, as it had been adequately employed as an undivided species in Fuchs (1973, 1974b). The African Slender-snouted Crocodile can today be effectively regulated without subspecies, and merely on a nation by nation basis. It would probably be unwise for CITES to continue regulating what I call *Mecistops cataphractus conigicus*, originally combined with the genus *Crocodylus* Laurenti) (Fuchs *et al.* 1974a). The 1974 two subspecies of *Mecistops cataphractus* hypothesis has not yet been tested.

Andy Ross reviewed crocodilians (explicitly acknowledged for *Crocodylus rhombifer*, but with input on various other taxa) for King and Burke (1989). My current mentor at the Netherlands National Natural History Museum (until recently the RMNH, but now NCB Naturalis), Dr. Marinus (Rinus) S. Hoogmoed was also a King and Burke (1989) crocodilians reviewer, as was my Ross and Mayer (1983) coauthor and trusted colleague Dr. Greg Mayer (still an EEW graduate student at the MCZ at the time). Also, I reviewed many crocodilian taxa for King and Burke (1989), and there were others, including Dr. George Zug of the USNM (Natural History). The list that we recommended included four subspecies of *Caiman crocodilus* (namely *apaporiensis*, *chiapasius*, *crocodilus* and *fuscus*), the full species *Caiman yacare*, *Crocodylus cataphractus* without subspecies, *Crocodylus niloticus* without subspecies, and *Crocodylus mindorensis* as a full species separate from *C. novaeguineae*.

Note that in their *Crocodylus mindorensis* Schmidt account, King and Burke (1989) cited Aoki (1985) as Riosuke (1985) (ie with the author’s name in reversed order). I remember one time when Andy remarked about how difficult it is to remember which order his friend’s names go, and said that his way of keeping it straight is that crocodile scientist Aoki’s nickname is Rio. The correct citation is Aoki, R., sometimes punctuated AOKI, Riosuke.

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C. Andy Ross Papers, Crocodile Scales and Angel Alcalá

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Abstract

When, in a recent obituary of Charles Andrew Ross (1953-2011), I said that my brother had authored or co-authored more than 40 scientific books and papers, it was a modest guess. The bibliography of the present paper lists more than 50. Additionally, the scalation of the Philippine Crocodile in Aoki (1985) counts as one of the major achievements of Dr. Andy Ross (honorary Ph.D. awarded by Silliman University). Among our shared interests, we studied the scientific names of crocodilians, and we have tried, whenever possible, to keep the full names and nicknames of our fellow crocodile scientists in print. With heartfelt gratitude and unbounded admiration I sincerely thank Professor Angel C. Alcalá for mentoring Andy, and for enabling me to say something new and potentially very useful about the ventral scalation of the living Crocodylia, and it has direct potential for CITES. The starting-point and stopping-point problems associated with the traditional (and variously defined) collar-vent count can now be avoided, and the collar itself is tentatively reinterpreted by me. It is the anterior row of the inter-forelimb scalation complex.

Introduction: Mr. Alligator from the Smithsonian

Back in the early 1970s when Charles Andrew “Andy” Ross and I went to Mexico and Central America and counted the scales on *Crocodylus acutus* and *C. moreletii*, we had postoccipitals in one transverse row, and then two or three transverse rows of nuchals, and then an unarmored space of bare skin at the base of the neck, and then the dorsal body scales to the back edge of the pelvis, and then double-crested caudals, and finally single-crested caudals. We additionally made a special study of lateral and ventral scales near the start of the tail, in the region immediately posterior to the cloacal oval, and whenever possible, we counted the belly scales also. Of these characters, the only scale count that reliably distinguished the two Central American *Crocodylus* species from each other was the subdorsal details in the basicaudal region.

Several years after the Central America trip, Andy and I were examining *Alligator mississippiensis* together in Louisiana, USA, and enjoyed the hospitality of Ted Joanen at Rockefeller Wildlife Refuge in Grand Chenier. To our surprise, it soon became evident that the American Alligator has an often somewhat vestigial transverse row of scales at the anterior end of its thoracic body armor, and (naively on our part) that this dorsal row had not been scored as zero in Central America, because it was completely absent in the American and Morelet’s Crocodiles. What we had noticed was the ancestral and theoretically always possible 18th transverse row, counting toward the neck from the base of the tail, PC18 in the terminology of Ross and Mayer (1983).

As detailed in Ross and Mayer (1983), *C. acutus* and *C. moreletii* have zero scales in PC 18, while *A. mississippiensis* always has at least two scales in this row. It was Andy, at Grand Chenier, who termed PC18 as “the row we don’t count” (meaning the row that the Ross brothers had not counted in Central America on *Crocodylus*), and we added it to our alligator data sheet. The scale counts reported in Ross (1975a), and later to the American Society of Ichthyologists and Herpetologists in Ross (1977b), and finally to much of the scientific world in Ross and Roberts (1979), all included this *A. mississippiensis* exoskeletal row, but it was not until Ross and Mayer (1983) that its one-to-one relationship with the 18th precaudal (counting away from the sacro-caudal juncture) endoskeletal vertebra became understood. However, understanding the cervico-thoracic juncture region in the American Alligator is different from understanding the nuchals, about which Ross and Mayer (1983) presented two alternative interpretations. It is thus no surprise that Ross and Ernst (1994) reported the neck as postoccipitals and three possible (of which the anterior two are obligatory) transverse rows of nuchals.

The data from Mexico and Central America, and from many museum collections in the USA, produced Ross and Ross (1974), about the special subdorsal scale irregularities (also called “caudal inclusions” or “intercalary rows” or “incomplete whorls”) always present in *C. moreletii*, as compared with *C. acutus* which sometimes has small and very few lateral inclusions but never the truly ventral and extensive kind. Later, Andy went to France, and in the Paris Museum examined the large stuffed specimen of a species-group name from Tampico, Mexico, and discovered that the published picture of it was inaccurate. The artist had removed some irregular basicaudal scales, and had created an American Crocodile tail on a Morelet’s Crocodile. Therefore, newly armed with the knowledge that the old French picture was misleading, Andy and I employed our neck scalation data to identify the name from 1869 as applying clearly to *C. moreletii* and in our resulting paper (Ross and Ross 1987) we confidently made the assertion that the name *mexicanus* is definitely not in the synonymy of *C. acutus*.

At times I have referred to the Ross brothers as a sibling rivalry, but this concept requires explanation, because Andy and I have always cooperatively shared our discoveries, and the other members of our family often complained that we talked together about crocodiles incessantly. Thus, all through the 1970s, 1980s and beyond, we helped each other at finding and photocopying literature, and most importantly, we shared the same definitions for head measurements, and we counted the dorsal and ventral scales on crocodilians in exactly the same way. One brother's scale counts and cranial size data could be reliably added to, or compared with the other's. Thus, our combined library and data set of measurements and scale counts grew rapidly. Everything that one brother learned, the other brother soon knew also. It was especially useful for me that Andy researched and functionally co-authored a major and monumental listing of crocodilian literature (The Max Downes Bibliography), which, although never published, I have long had a copy. We eventually further cooperated by dividing the crocodile world into regions of individual expertise, and thus while I was concentrating on the Cuban Crocodile for Ross (1998), Andy was championing the Philippine Crocodile [eg co-authored paper by Messel *et al.* (1992)] and, separately he was investigating the crocodilians of mainland Asia [eg Ross (1975b) about *Gavialis gangeticus*].

Discussion Part 1. Doctor Crocodile of the Philippines

In his "The Philippine Crocodile" circular from Silliman University, Ross (cf. 1980) illustrated *C. mindorensis* as having an obvious transverse row of postoccipital scales, and thus distinguishable from *C. porosus* in the Philippine Islands. This simple scalation dichotomy was further employed in Ross and Datuin (1981a) for separating the Indopacific saltie (*porosus*) from the fresh water endemic (*mindorensis*) in the Philippines, including illustrations of the neck in both taxa. These drawings of neck scales were not included in Ross and Datuin (1981b). There were no scale counts in Ross (1982a), but the historical literature about the finding and naming of *C. mindorensis* was detailed, and further the coloration and ecology and the critical need for conservation was discussed with regard to both of the two crocodile species in the Philippines. Based on his own observations, Andy decided that the need for captive reproduction of *C. mindorensis* was crucial and absolutely urgent, and by the time of Ross (1982b), his internationally funded initiative was tentatively considered a success, and this potential was clearly a credit to the efforts of Professor Alcala. For an excerpt from a letter from Dr. Alcala (to the CSG) about the Silliman University Marine Laboratory, and also a report by Dr. Jose L. Diaz about the separate RP-Japan Crocodile Farming Institute (CFI) development on Palawan [see CSG Newsletter 6 (1987): 14-15, including an aerial photo of the new CFI installation]. The next year, in Alcala *et al.* (1988), the Philippine Crocodile breeding project at Silliman University was reported to the Philippine public. Later, Andy brought the Philippine Crocodile situation up to date at the Thailand meeting of the CSG (Ortega *et al.* 1994).

With the conservation plea published, Andy returned to scale counts, and to documenting the former and present geographic distribution of *C. mindorensis* in Ross and Alcala (1983), which added a table of data supporting the postoccipital scales differentiation between *C. mindorensis* and essentially sympatric Philippine *C. porosus*, and similarly a table of data distinguishing these two species from each other by ventral scale counts (from the collar to the cloacal disturbance) on the belly. The collar-vent character worked for separating these two species in the Philippines with a sample of 44 *C. mindorensis* and 32 *C. porosus*. The C-V range in the so-called Philippine "freshie" was 22 to 25 (average 23.9), compared with 29 to 34 (average 31.7) in the so-called Philippine "saltie". The PC-26 row similarly lacked overlap, because the endemic *C. mindorensis* had 4 to 6 (average 5.6) postoccipital scales, while the widespread *C. porosus* had 0 to 2 (average 0.5) in Ross and Alcala (1983). Of special note is a photograph in Messel *et al.* (1992) showing 6 postoccipitals (3-3) in PC-26, minor nape scales in PC-25 and PC-24; and, three transverse rows of nuchals, including two kinds of bilateral asymmetry. On this juvenile's left side in the anteriormost row (PC 22+23 compound), the lateralmost nuchal scale is subdivided as PC-23 and separately PC-22; and, in the posteriormost row, PC-19 has two small scales (one larger, one smaller) separated from each other by skin.

As detailed in Ross and Mayer (1983) below, *C. mindorensis* somewhat resembles *C. novaeguineae* from Irian Jaya (Indonesian New Guinea) and Papua New Guinea. My impression is that the so-called New Guinea "freshwater" crocodile (*C. novaeguineae*) has more regular and cleaner neck scalation than the so-called Philippine "freshwater" crocodile (*C. mindorensis*), and for comparison with the Messel *et al.* (1992) photograph, there is a photograph in Cox *et al.* (2003).

The Ross and Alcala (1983) article also presented taxon discriminating data about the bones and sutures on the palatal surface of cleaned skulls of *C. mindorensis* and *C. porosus* in the Philippines. Thus, with the skulls, neck scales, belly scales, coloration and distribution of the endemic Philippine Crocodile documented, Andy presented the CSG with an overview about *C. mindorensis* and *C. porosus* (distribution, commercial utilization, farming and conservation) in the Philippine Islands in Ross (1984, 1986).

In Ross (1986), Andy expanded his scope to include *C. novaeguineae* and *C. siamensis*, and comparative data about neck scales and belly collar-vent counts in all four of the species inhabiting the region near the Philippines, along with discussion about New Guinean and Indonesian crocodile history, and the ecology and human utilization of all four taxa. The 1980s were a cosmopolitan time for Andy, and while documenting the situation in Southeast Asia, he co-authored an immense bibliography and set of subject indexes to the literature pertaining to the American Alligator (Brisbin *et al.* 1986a,b), and

got his own SSAR catalog account for Morelet's Crocodile published (Ross 1987).

The old fashioned dichotomy between a Philippine "Freshwater" species and a Philippine "Saltwater" species was challenged and explicitly discussed by Ross (2008a), who argued that "*Crocodylus porosus*, the so called 'Saltwater Crocodile' is, in fact, the common and ubiquitous crocodile of the Philippines and found in almost all recognizable freshwater (as well as estuarine) habitats." The same problem can occur in Papua New Guinea, as Ross (2008b) explained, saying that "I have observed both species on banks of the same river within a km of each other. The species are known to commonly overlap" (meaning *C. novaeguineae* and *C. porosus*). Based on his own explorations, Andy has long championed the vernacular name "Indopacific Crocodile" for *C. porosus*, and prominently employed it in his 1989 book "Crocodiles and Alligators" (Ross 1989c,d, 1990 a-c, 1992a,b) but in a review of the book, Whitaker (1990) said "I don't agree with changing the name of the Saltwater Crocodile to 'Indo-Pacific' crocodile... It will remain the 'salty' of croc people all over the world". Note that Rom spelled it "salty" as opposed to "saltie" (which many other authors, myself included, seem to prefer).

Discussion Part 2. Editor of widely read crocodiles book

I have never seen the 10-page long Ross (1978) paper; but in contrast, Andy's book "Crocodiles and Alligators" (originally produced by Weldon Owen Pty. Limited) is extremely widely distributed, and there are three English language releases (Australia, USA, England; 1989c,d, 1992a respectively). There are also French (Ross 1990a), German (Ross 1990b), Italian (Ross 1990c) and Dutch (Ross 1992b) versions [the latter has an added Foreword by Marinus (Rinus) S. Hoogmoed]. All 7 separate printings have exactly the same paginations (see examples of authored text below), except that the index in German is one page shorter. There was also a timely review of "Crocodiles and Alligators" by Heaton-Jones (1989).

Sometimes subtitled "An illustrated encyclopedic survey by international experts", the monumental work "Crocodiles and Alligators" was edited by Andy, and is considered "his" book, but it is a compilation of many individual papers, including a chapter by Ross and Magnusson (1989c,d, 1990a-c, 1992a,b), which did the species accounts for the living taxa. Additionally, Ross (1989b) is the taxonomic list as Andy saw it at the time. Note that he did not recognize any Fuchs subspecies, although some subspecies of common caimans were listed, including one typographical error: *Caiman crocodilus fusckis* (sic) should be *fuscus*. Interestingly, Ross (1989b) consistently correctly spelled Crocodylia with the letter-Y, while in the Introduction (page 10), he sometimes also correctly spelled Crocodilia with the letter-I, reflecting the indecision prevalent in the 1980s (eg Ross and Mayer 1983).

Technically, the Introduction page in the English language editions (1989c,d, 1992a) said "Crocodylia" with an I, while in contrast the Italian (Ross 1990c) and Dutch (Ross 1992b) versions said "Crocodylia" with a Y. The French version (Ross 1990a) did not name the order, and instead employed the vernacular synonym "les crocodiliens". Note that Ross and Magnusson (1990b) said "Unterfamilie Crocodylinae" with the Y-spelling, but the (Ross 1990a) version said "sous-famille des crocodilins" in French. In Ross and Magnusson (1992b) it is "subfamilie Crocodylinae"; and, in (Ross 1990c) it is "sottotfamiglia Crocodylinae"; and, lastly, on page 64 it is "subfamily Crocodylinae" in the (Ross 1989a,b, 1992a) English language versions. Nonetheless, Ross (1989a,b, 1990c, 1992a) recognized the Crocodylia, Crocodylidae, Crocodylinae, Alligatorinae and Gavialinae, but Ross (1990a) is different (including "sous-famille des alligatorinés" and "sous-famille des gavialinés"). In all cases, *Tomistoma schlegelii* is discussed and tentatively (and in my opinion, correctly) included within the crocodiles group, as opposed to the alligators or gharial. Concerning the Crocodilia or alternatively Crocodylia spelling question, I today endorse Crocodylia, as recently justified by Ross *et al.* (2010)

The color paintings in Ross and Magnusson (1989c,d, 1990a-c, 1992a,b) are terrible, and Andy was furious about them. As scale counters, he and I freely say that the taxonomic account illustrations are not reliable. Otherwise, however, the book is a classic. It is the first and the best of its kind, and by far the most cited of the so-called "coffee table" books about crocodilians in the scientific literature. There is even a "box" by me about the evolution of the dorsal neck, body and tail scales, citable as F.D. Ross (1989), in which I summarized some of the most important concepts from Ross and Mayer (1983). In the 1990 French translation, my one page box was titled "Variations du bouclier dorsal", and in 1990 in Italian "Variazioni nella corazza dorsale", and in 1992 in Dutch it became "Variaties in rugpantser". In all cases, the page citation for F.D. Ross (1989) is the same, and similarly the Ross and Magnusson (1989c,d, 1990a-c, 1992a,b) chapter, and also Andy's one page taxon listing (Ross 1989c,d, 1990a-c, 1992a,b), all retain their page numbers. This also applies to the Pooley and Ross (1989c,d, 1990a-c, 1992a,b) on "Mortality and predators" (pp. 92-97, 99-101), Fuchs *et al.* (1989c,d, 1990a-c, 1992a,b) on "Crocodile skin products" (pp. 188-195) and Ross *et al.* (1989c,d, 1990a-c, 1992a,b) about "Farming and ranching" (pp. 202-213).

I have often said that "things happen slowly in crocodiles" (meaning crocodile studies), but in the case of "the row we don't count" it is worth remembering that it was in 1972-1973 in Central America (and museum collections) while examining *C. acutus* and *C. moreletii*, that we did not count PC-18, and it was in 1974 in Louisiana that we noticed PC-18 on *A. mississippiensis*, and then in Ross and Roberts (1979) that the American Alligator's anteriormost body row was mentioned in print ("the 18 transverse body scale rows"), and then Ross and Mayer (1983) developed, illustrated and proposed as

a global model (in the “peer reviewed” literature), and then explained briefly in the CSG Newsletter (1987 6: 15) as a technical note (written by F.D. Ross), and lastly in F.D. Ross (1989c,d, 1990a-c, 1992a,b) the basic idea and its significance was reported to the world in five languages. In this case, a development in crocodile studies appeared to be happening remarkably fast [see also Aoki (1985) below].

To my surprise, the 1995 guide for the identification of CITES crocodilians, despite being scientifically advised by James Perran Ross and F. Wayne King, who both knew about Ross and Roberts (1979) and Ross and Mayer (1983), did not adopt the new insight concerning the dorsal scalation. The CITES guide counted the number of transverse rows of ventral scales in the collar-vent series, but did not report the number of transverse dorsal rows on the body. It was content to note that in *C. acutus* the “dorsals” (which are universally PC-1 to a theoretically possible PC-18) are not continuous with the nuchals, while in *C. johnstoni*, *T. schlegelii* and *G. gangeticus* the dorsals are continuous with the nuchals (meaning that PC-15, PC-16, PC-17, PC-18 and PC-19 are present). Again speaking as a dorsal scale counting person, the taxon account pictures in the 1995 CITES guide are not trustworthy, and (optional) did not show the dorsal scalation from directly above the animal. It was an opportunity lost.

Perhaps in 1995 Wayne King and Perran Ross decided that the Ross and Mayer (1983) method was inappropriate for identifying hornback hides, and too technically difficult on whole animals because it involves feeling the posterior edge of the pelvis, and estimating the level of the out-stretched femur bones. However, the result is remarkably accurate for locating the sacro-caudal juncture with true homology, and thus defining the first precaudal transverse row of scales (PC-1), and from it also the level where the tail begins (caudal row 1). Further, the location of PC-1 can be determined often (but not always) by examining a specimen (including flat skins and photos of them) viewed from directly above it. However, because the Ross and Mayer (1983) model for the nuchals and postoccipitals on the neck involved their interpretation as compound rows with uncertainty in several taxa, and because an anatomist specializing in muscles, Dr. Eberhard Frey, had already differed from Ross and Mayer (1983) about vertebral correspondences on the neck (but theoretically not on the body and tail) of the American alligator, it is perhaps understandable that the 1995 CITES guide stayed within the realm of established and traditional practice, and that it handled the variation in neck scales with pictures and a terminology not involving PC (precaudal transverse dorsal row) numbers. Note that, published in 1988, Dr. Frey’s dorsal scalation diagrams are, in my opinion, untrustworthy (I would need multiple specimens to confirm his sacro-caudal juncture; and, separately, on the neck, his schema has “PC23” and “PC24” and “PC25” definitely wrong. There is a fundamental difference of interpretation about the postoccipital region, and Frey is in error. I trust Eberhard Frey about crocodilian musculature, but his sample was one specimen, and thus, for the dorsal scalation of *A. mississippiensis*, I recommend Ross and Roberts (1979), and Ross and Ernst (1994), and additionally note that Ross and Mayer (1983) explicitly stated that in the American Alligator, “the most prominent nape row is PC 25, ordinarily with two, but with up to six ossified elements. PC 25 is the postoccipital of Ross and Roberts (1979); in *Crocodylus* this term refers to PC 26.”

Three additional works that opted to not report dorsal transverse scale rows with their precaudal (“PC”) and caudal (“C”, counting posteriorly away from the sacro-caudal juncture) numbers in the Ross and Mayer (1983) terminology were Ross (1987), Ross and Ernst (1994), and Ernst *et al.* (1999). Note that about the Morelet’s Crocodile, Ross (1987) said “the neck armor normally consists of four or more postoccipital, and six or more nuchal scales. The tail exhibits ventral and often ventro-lateral intercalary irregularity of the anterior caudal whorls. The scales on the flanks of the rear legs are smooth. The contiguous dorsal scales are asymmetric, often with a reduction in the number of contiguous ossified scales found in some rows across the back at midbody.” About the American Crocodile, Ernst *et al.* (1999) said “the cervical shield is larger than the surrounding scales and is normally composed of six (often less, seldom more) scales. The nape has four occipital scales. The dorsal body armour usually has 16 (14-17) continuous precaudal rows that vary in both number and size of scales per row; at least some of the scales are asymmetrical. Midbody scale rows normally have 4 (2-6) contiguous scales per row. Ventral scales are in 26-34 transverse rows.”

Things really do happen slowly in crocodile studies. The word “nape” was defined by Ross and Mayer (1983) as the postoccipital (or “occipital”) region immediately posterior to the cranial table. The cervical shield is the nuchals cluster. PC-19 to PC-23 are nuchals, and PC-24 to PC-26 are nape scales. Be advised, however, that in the old literature, the words “nuchal” and “nape” can both mean the whole dorsal surface of the neck, and the “nuchal scales” often meant PC-26 (and sometimes PC-25 and PC-24 also), while simultaneously the “nuchals” of today were called the cervical shield. Thus, postoccipitals and occipitals (nape scales, PC-24 to PC-26) are different from nuchals (cervical shield, PC-19 to PC-23) in the SSAR species accounts for *C. moreletii* in 1987, and *C. acutus* in 1999. The “continuous” dorsal armor consists of transverse rows that directly border each other (as opposed to being separated from their neighboring transverse row by a space of unarmored skin). The “contiguous” scales within a transverse row each similarly directly contact their neighbor(s) within the row (as opposed to detached “flank” scales). In these two individual New World *Crocodylus* species, both of which are characterized as being remarkably irregular in scale placement, and sometimes with an isolated scale obviously missing from a transverse row, the definition of contiguous gets slightly stretched in an effort to functionally agree with the global living crocodilian model, in which there is a “carapace” on the body.

Discussion Part 3. The resurrection of *Crocodylus raninus*

Philippine *C. porosus* and *C. mindorensis* received only very minor mention (no descriptive data) in Ross and Lazell (1990: Dinigat and Siargo islands), and also later in Ross and Gonzales (1992: the Catanduanes); and thus in contrast, it was Ross (1990d) about the Kalimantan Island (Borneo Island) *C. raninus*, compared with *C. siamensis* and *C. porosus*, in which Andy returned to presenting scalation data, and in Ross (1990d) he explained that “scale counts follow Ross and Roberts (1979), King and Brazaitis (1971), and Brazaitis (1973, 1974). Dorsal neck armor terminology of Ross and Mayer (1983) is given in parentheses where pertinent”.

In Ross (1990d), Andy demonstrated the throat scales as a method of distinguishing the Siamese Crocodile, when compared with any other *Crocodylus* in the Indopacific region. The (Ross 1990d) paper included a graph (Fig. 2) which clearly showed that the postoccipitals (PC-26) group together *C. johnstoni*, *C. novaeguineae*, *C. mindorensis*, *C. raninus*, *C. siamensis* and *C. palustris* as regional species that are distinguishable from *C. porosus*. His sample size for the Philippine Crocodile in Ross (1990d: Fig. 2) was 52 animals. In Ross (1990d: Fig. 3), *C. johnstoni*, *C. novaeguineae*, *C. mindorensis* and *C. raninus* grouped together as distinct from *C. siamensis*, *C. palustris* and *C. porosus* when their numbers of ventral scales in the collar to the cloaca series (C-V, see definition below) were plotted. Lastly, in Ross (1990d: Fig. 5) the throat scales grouped *C. johnstoni*, *C. novaeguineae*, *C. mindorensis*, *C. palustris* and *C. porosus* together, and separated them all from *C. siamensis*. These findings, plus additional comments concerning individual specimens and populations that deviate from the expected (do not exactly agree with the scale counts or other characters of any of the IUCN- or CITES-recognized species in Southeast Asia), were presented by Ross (1994). Additionally, Andy's optimistic opinions about the CFI project were paraphrased in the CSG Newsletter [1994 13(2): 18] report of the 1994 CSG Steering Committee meeting. There is a photo of Andy (centre) at the RP-Japan Crocodile Farming Institute (CFI) captive-breeding facility in Puerto Princessa City, Palawan, in Messel *et al.* (1992).

The Ross (1992) paper clarified *C. raninus* with a lectotype; and, three years later in Ross *et al.* (1995), Andy and others did the same for the Siamese Crocodile. The abstract of Ross *et al.* (1995) was paraphrased by King and Ross (1995). In addition to selected skull characters, there was now a system of scale counts (postoccipitals, collar-vent, and throat) that, when combined, distinguished *C. raninus* from all other *Crocodylus* in the Borneo Island (Kalimantan) region. An official report (Ross *et al.* 1996) was not published, but Wirjoamodjo (1996) provided a short and informative summary of it, and included the news that “two captive crocodiles... exhibited scale patterns similar to the type of *C. raninus* and other probably related crocodiles *C. mindorensis* and *C. novaeguineae* (north coast population)”.

Finally, in Ross *et al.* (1998) it was reported that Andy and others had gone to Kalimantan and examined a large number of crocodiles in the wild and also in captivity, and among the latter there were a very few *C. raninus* still alive. Circumstantial evidence indicated that *C. raninus* could still be breeding in the forest, and thus the IUCN was officially offered the opportunity to add *C. raninus* to the CITES list; but alas, this freshwater reptile, more endangered than even the Philippine, Cuban and Siamese Crocodiles, has only approached being recognized as a taxon of concern to CITES. The species “*Crocodylus raninus* Müller and Schlegel 1844” was listed alphabetically between *C. porosus* and *C. rhombifer* in a checklist (World Conservation Monitoring Centre 1993) with the taxonomy and systematics of the living crocodilians probably significantly authored by Brian Groombridge. It was concluded that “the species may be comprised of animals from both Appendix I (Malaysia: Sabah, Sarawak) and Appendix II (Indonesia: Kalimantan) populations; the appropriate listing remains to be determined. The IUCN Red List status category has not yet been assessed.”

Note that Das and Charles (2000) was reprinted in 2002 [CSG Newsletter 21(1): 10-11], titled “New record of a freshwater crocodile from Brunei”, with the following note from the editors (F.W. King and J.P. Ross). “We reprint the article above with caution due to the continuing uncertainty about exactly to which crocodilian taxon the name ‘*raninus*’ should be applied. C.A. Ross 1990 and 1991 contends that the specimens he has designated differ from both *C. porosus* and *C. siamensis*, but there is little evidence either that it is restricted to Borneo or that it differs significantly from *C. novaeguineae* from the north coast of New Guinea. We are aware of genetic analyses in progress and in press that will shed much needed light on this vexing problem. We also note that the author's reference above to the estuarine habitat of *C. porosus* is in error, the species is known to thrive in fresh water swamps. While the discovery of an additional skull assignable to ‘*raninus*’ sensu Ross 1991 is of interest, the taxonomic position of these specimens and the diversity of freshwater crocodilians in Borneo remains to be determined.”

For an update and focus on the endangered population of *C. siamensis* in East Kalimantan, see Kurniati (2005) which cites Cox (2004). Ortega and Regoniel (1994) provide an update on “Conservation, management and farming of crocodiles in the Philippines” and Regoniel *et al.* (1994) on “Distribution and status of crocodiles in Palawan Province”. From personal correspondence with Patrick Regoniel (1992 and 1994), I know that he had some bad luck counting the dorsal scales on the *C. mindorensis* at the old CFI, and I hope that his data (n= 368) will be revised and get published. Recently, Ross (2008b) said that “almost all *Crocodylus mindorensis* used as founder stock at the Palawan Wildlife Rehabilitation and Conservation Center (formerly the Crocodile Farming Institute, CFI) were obtained from captive sources.” Therefore, the

locality data of Regoniel's sample, and others like it, are primarily anecdotal. Today, it can be generally presumed that captive *C. mindorensis* have been transported from one island to another within the Philippines (the whole archipelago), and thus the release of captive-reared stock to the wild is not a simple question (Ross 2008b).

Discussion Part 4. A working lifetime counting scales

Andy was effective at getting papers published, and in the process was a pragmatist. For example, while negotiating the wording in Ross and Ross (1987) about the neck scales of the Tampico, Mexico, crocodile named *mexicanus* Bocourt, 1869, Andy argued that rather than calling the postoccipitals in *C. moreletii* and *C. acutus* as transverse row PC-26, he preferred keeping them as postoccipitals, because he had illustrated them under that name for *C. mindorensis*, and the meaning of the term was widely known. In hindsight, he was perhaps correct because in some taxa there is more than one transverse row, and when PC-25 and PC-24 are present, always vestigially, interpretation becomes very difficult. The CITES guide in 1995 followed the safest model by calling PC-24, PC-25 and PC-26 collectively as postoccipital scales.

A product of the Louisiana (Rockefeller), Georgia (Okefenokee) and Florida (Gainesville and Everglades) trip in 1974 counting scales and taking blood samples, Khan *et al.* (1980) is Andy's (and my) contribution to veterinary research, for which Andy had an explicit US Federal Permit (see Ross 1974). This business of needing a permit to examine protected animals started in the early 1970s, and persists in many places today. It makes studying wild crocodilians extremely difficult, and has slowed or prevented much research that probably should not have been regulated at all. Counting scales and taking blood did not hurt the alligators. The Khan *et al.* (1980) paper reported a haemogregarine parasite in the blood of *A. mississippiensis*, similar to Villapa *et al.* (1992).

Sightings of crocodiles on Dalupiri Island in the Batan and Babuyan region of the Luzon Strait in 1990 were noted in Ross (2005), but species identification was not possible. Following up on the Ross (2005) suggestion, Oliveros *et al.* (2005) reported the capture of a Caucauyan Creek crocodile, and asserted that "the presence of six postoccipital scales and 25 transverse ventral scale rows identifies the animal as *C. mindorensis*". See Oliveros *et al.* (2006) for the detailed report on the Batan-group (Luzon Strait) island in the northern Philippines.

Also relevant to crocodilians, Ross and Davenport (1992) reviewed Steve Grenard's (1991) book, and thus Andy got his first publication in the prestigious magazine *Copeia*. The following year, Ross (1993) reviewed a book about the avifauna of the Philippine Islands, which by then he had explored rather extensively, often in the company of natural history specialists, as evidenced by Kennedy and Ross (1987) and Ross and Ramos (1992) about birds, Ross *et al.* (1988) and Ota and Ross (1994) about several snakes, and Ross (1989a) and Ota and Ross (1990) about lizards. All of these snake, lizard and bird papers dealt directly with the Philippines (and Taiwan), but Ross and Crumley (1982) was about a tortoise from India and Ross (1988) was about birds on New Caledonia.

Discussion Part 5. Scalation of the Philippine Crocodile

Scalation drawings of the endemic Philippine Crocodile are relatively scarce, and of variable quality. The dorsal view of the head-end, showing four thoracic rows, an unarmored space at the level of the front legs, and two transverse rows of nuchals (4 anterior, 2 posterior), and the unarmored space between the nuchals and the postoccipitals (of which 6 of the latter are shown, 3 and 3 in one transverse row that is distinctly separated across the midline) in Ross (cf. 1980) was repeated in Ross and Datuin (1981a,b: Fig. 1a). Additionally, in Ross and Datuin (1981a,b: Fig. 1b) an equivalent dorsal drawing (4 thoracic, 2 nuchal rows as 4 scales over 2, and no postoccipitals) of *C. porosus* was given for comparison; and, also a ventral map of the scalation (throat, collar, transverse belly rows, cloaca, and subdorsal caudal whorls) of a general crocodile (not identified to species) was added.

The identification of the four thoracic transverse dorsal rows of scales shown in Ross (cf. 1980); and Ross and Datuin (1981a,b: Fig. 1a) as probably being PC-14 to PC-17 happened in Ross and Mayer (1983) who illustrated the neck of a specimen of *C. mindorensis* that has three transverse rows of nuchals (Ross and Mayer 1983: Fig. 7c), although PC-19 is somewhat vestigial (reduced to a single large scale, and a smaller one). Keeping in mind that the anteriormost row of nuchals is PC-22 and PC-23 combined together as PC-22+23 compound, and that PC-21 and PC-20 also combine together as PC-20+21 compound, but PC-19 is not a compound row; and, that the nuchals in *Crocodylus* are PC-19 with at most two scales in it, PC-20+21 generally with at most two scales in it, and PC-22+23 usually with four scales in it; and, that the postoccipitals in the Philippine Crocodile are PC-26, the following quotation from Ross and Mayer (1983) is based on 22 specimens (collectively called *novaeguineae*), of which 5 are from the Philippines (Ross and Mayer 1983).

"In *Crocodylus novaeguineae*, the continuous and contiguous precaudal armor is regular in scute dimensions and keel row alignment. As in *C. porosus* and *C. siamensis*, interscute triangles occur. There are 16 or 17 continuous precaudal rows, with 7 to 12, usually 8, contiguous scutes at midbody. Detached flank scutes, though reduced, sometimes form an additional keeled row on each side. The thoracic and cervical armors are separated by spaces of skin. PC 18 is represented

by vestiges or elements separated on the midline. PC 19 is absent, or, in a single specimen, rudimentary. PC 20+21 has two scutes, and PC 22+23 has two large median elements, and may have one or two smaller elements on either side. In many individuals, smooth or fine granular skin separates the two cervical rows (PC 20+21 and PC 22+23) or the left and right halves of one or both. Sometimes PC 22 and PC 23 are not compound. All or any combination of cervical scutes may be noncontiguous. There are 4 to 6 scutes in PC 26. PC 24 and PC 25 are sometimes not evident, but are usually present as bluntly keeled scales.

“Previous authors have differed on whether the freshwater crocodiles of the Philippines should be recognized as a species (*mindorensis*) distinct from *C. novaeguineae*, or merely as a subspecies of the latter. Wermuth and Mertens (1977) have elevated *mindorensis* to full species status. Tables 1 and 2 include with *C. novaeguineae* data for a few *mindorensis*. The preceding account of the cervical armor, however, applies only to *C. novaeguineae* proper. *C. mindorensis* differs from *C. novaeguineae* in that PC 19 is better developed, being present as one or two elements in three of five individuals; PC 22+23 has four elements; the scutes of the cervical shield are little or not at all separated by skin; and the nape scutes between the cervical shield and the prominent nape row (PC 26) are better developed, sometimes in two distinct rows. The extremal count of twelve scutes at midbody is from an individual from the Philippines. In general, *mindorensis* has a more well-developed armor than *novaeguineae*, though this conclusion is based on a small sample and should be considered tentative.”

The best artwork and most informative suite of drawings of *C. mindorensis* is from Andy’s personal (I think they did fieldwork together) friend “Rio” from Japan, and Aoki (1985) is the most important paper about the scalation of the two species of *Crocodylus* in the Philippine Islands. It is certain that Andy was the person who explained the Ross and Mayer (1983) method to Aoki, and as far as I can see, Aoki (1985) got it right. His illustrated analysis of the dorsal armor is correct, and further, he illustrated and detailed the ventral scalation of a *C. mindorensis* specimen accurately as well. He said (page 8) that the collar-vent count is 25 in the Philippine Crocodile, based on its type-description from Karl Patterson Schmidt in 1935. Note that the photo in Oliveros *et al.* (2005) is said to show 25 ventral scale rows, but is not clear enough to verify their count.

I do not pretend to really know if the “Mindoro or Philippines Crocodile” is a species or a subspecies. About it (as “*Crocodylus novaeguineae mindorensis*”) it was recently said that “this population is listed by CITES as a subspecies, although all systematists now recognize it as a full species” (WCMC 1993). Peripherally, yet relevant to their attitude about subspecies in general, WCMC (1993) did not recognize any subspecies in “*Crocodylus cataphractus*” and “*Crocodylus niloticus*” (and thus they declined the opportunity to accept any of the Fuchs subspecies from Africa), but this same 1993 list said that “*Caiman yacare* Daudin 1801 (= *Caiman crocodilus yacare*; includes *Caiman crocodilus matogrossiensis* and *Caiman crocodilus* [(sic) = *Caiman crocodilus*] *paraguayensis*)” for the Yacare Caiman. I am convinced that they discussed two Fuchs subspecies too many in the Latin American caimans. In contrast, however, I have no opinion about the assertion in Aoki (1985) that the Philippine population of the Indo-Pacific Crocodile is *C. porosus biporcatus*. What I can say today is that Rio Aoki deserves credit for bringing the combination *Mecistops cataphractus* (Cuvier) back into common parlance.

Special Section. Two of Rio Aoki’s (1985) excellent illustrations

Similar to the treatment of *C. mindorensis* and *C. novaeguineae* in Ross and Mayer (1983) above, I today note that the dorsal scale patterns on the neck of these two species resemble each other to such a remarkable extent that, in truth, I can not predict the locality (Philippines versus New Guinea) of a specimen from photos of its cervical and thoracic scalation. Both taxa have remarkably variable nuchals, and although some individuals have the classic *Crocodylus* four over two (total 6 scutes in the cervical shield), other specimens exhibit various degrees of degeneration of usually the anterior transverse row (PC 22+23 compound), and sometimes it and also PC 20+21 can (both, or either one individually) have lateral scales that contact (or nearly contact) the nuchals, creating the temptation to count these distal elements as contiguous members of a transverse row.

I have seen photographs from Andy that show midline flexible skin separating the left and right halves of PC 22+23 from each other in *C. novaeguineae* (California Academy of Sciences, south coast of Papua), and also in *C. mindorensis* from the Philippines (US National Museum, CAR field series). Similarly, Andy’s photos show that PC 22+23 can be reduced in size in comparison with PC 20+21 in both taxa. Further, the flexible space posterior to PC 20+21 can have traces of PC-19 or alternatively PC-18 (it is often impossible to tell which one), or both. Finally, there can be division of PC 22+23 into its component PC-22 and PC-23 transverse rows (to a greater or lesser degree), often asymmetrically; and, in these cases, three transverse rows of nuchals are present, but the third row is not PC-19. The high degree of variability observed among the nuchal scales in *C. mindorensis* and *C. novaeguineae* gives me the impression that having a classical *Crocodylus* shield protecting the neck is not important to these animals. To the contrary, it is apparently obtaining greater flexibility that is happening. The PC-19 to PC-23 region can have thoracic-size scales in extreme cases, but when individual scutes get smaller, there becomes more of them, and intervening spaces of granular skin make the neck shield less rigid.

Similarly, the postoccipital scales on the nape in *C. mindorensis* resemble those on the south coast *C. novaeguineae* in Andy's pictures. The most obvious transverse row is PC-26, but elements of PC-25 and PC-24 can be only slightly smaller. The Jack Cox dorsolateral neck photograph in the CSG Newsletter [22(2): 7] was said to show a "postoccipital scute pattern of two rows of three enlarged scutes" on a southern *C. novaeguineae*. Given bilateral symmetry, I see one enlarged transverse row with approximately three scutes on either side of the flexible skin midline gap, and the smaller scales (PC-25 and PC-24) between the postoccipitals (PC-26) and the anterior row of nuchals (PC 22+23) are too reduced to count.

In the Wayne King truly dorsal view neck photograph of *C. mindorensis* in the CSG Newsletter [11(1): 20], one can see PC-26 as having 6 scales (3 left, midline gap, 3 right), and PC-25 and PC-24 are reduced to become three-dimensional reflective symmetry, meaning functionally working as granular scales similar to the lateral scalation on the neck. Some endemic Philippine and New Guinea *Crocodylus* can have essentially identical neck armor and cervico-thoracic flexibility zones, with PC-17 appearing to be the commonest anterior end of the thoracic zone of the carapace in both taxa.

Museum collections tend to accumulate unusual specimens, and often subjectively select for strange and odd nuchals and other dorsal scalation peculiarities beyond the normal. Some of the pictures that people have sent to me have been totally unexpected extremes of variation. Rather than illustrating known anomalies, fascinating (and sometimes instructive) as they are, my Figure 1 is a drawing of what Andy's friend Rio Aoki thought was a normal and representative *C. mindorensis*.

Figure 1 is appended so that it can fill a whole page. Counting the dorsal scales involves knowing which ones don't count. Thus, because it has been intelligently edited, this drawing from Aoki (1985) is easier to discuss than a photograph (or even a specimen) would be.

Starting at its anterior end, the specimen illustrated in Aoki (1985: Fig. 5) has 6 postoccipital scales in transverse row PC-26, because even though they don't all actually contact each other contiguously, it fits the general *Crocodylus* model. Similarly, this Figure 1 example of *C. mindorensis* has four scutes in PC 22+23, even though the lateralmost scutes at the two distal ends of this compound transverse row lack strict contiguity. They are interpreted as present, but slightly vestigial. The median pair of large scutes in the anterior row of nuchals physically contact each other just enough that they clearly qualify as contiguous, although to a lesser degree than in the transverse row immediately posterior to it (PC 20+21 compound), which has two scutes with complete midline contiguity. Thus, because PC-19 is completely absent in this drawing, the cervical shield consists of six nuchals (four over two), and the specimen agrees with the Philippine endemic crocodile neck scales in Ross (cf. 1980), and Ross and Datuin (1981a). Also, it agrees with the picture in Ross and Mayer (1983: Fig. 7c), except that my 1983 drawing has two vestigial and bilaterally asymmetrical and noncontiguous scales identified as PC-19. So, the 6 postoccipitals (PC-26) are separated from the 6 prominent nuchals by a space of granular skin, and the 6 nuchals (PC 22+23 compound and PC 20+21 compound) are similarly separated from the thoracic armor by flexible skin; and, finally, sometimes PC-19 is vestigially present.

Having analyzed the neck, the next question concerns where the thoracic dorsal armor really starts. We know that PC-19 is absent in Figure 1, but we do not know if the vestigial transverse row at the anterior edge of the carapace is PC-18 or PC-17. The prediction from Ross and Mayer (1983: Table 1) is 0 to 5 scales in PC-17, with a mode of 4 scutes (often variously vestigial and irregular in size). Further, the same table reported PC-18 as always zero ($n = 5$ *mindorensis*). So, to see if Aoki's (1985: Fig. 5) is really missing PC-18, and has PC-17 with 4 vestigially represented scales (not truly contiguous, but they qualify as formerly contiguous in this case), we need to find PC-1 and then count from the sacro-caudal juncture going towards the neck (PC-1, PC-2, PC-3, etc.) until the anterior edge of the carapace is reached. This vestigial row that qualifies should be the 17th precaudal row, but Ross and Mayer (1983) predict that it could possibly be PC-16, with both PC-17 and PC-18 absent.

Fortunately, PC-1 can usually be identified on a truly dorsal view photo or extremely careful drawing. It is the transverse dorsal row immediately posterior to the narrowest row across the pelvic region, meaning having the shortest transverse length across the four scales in PC-2. In Figure 1, the tiny extra scale in (and inside) PC-2 does not count, because it is obviously derived from one of the four major scales. However, in contrast, the small scale shown at the left distal end of PC-1 does count, and its presence makes PC-1 slightly wider than PC-2. Thus, Aoki's drawing shows two transverse rows of dorsal caudal scales (C-1 and C-2, counting away from the sacro-caudal division); and, anterior to C-1, there are 17 continuous transverse rows that collectively form this crocodile's carapace.

The widest carapace row at approximately midbelly level is composed of 8 contiguous scales, and at that level there are detached flank scales (one shown slightly separated from each distal end of the contiguous row). Unlike the interscale spaces of granular skin that were tolerated in PC-17, the granular skin separating the carapace from the flank scales in the midbody region (PC-7 to PC-14 in Rio's drawing) is not tolerated. The carapace maximum on this specimen is 8 scales across, and on this individual it happens in PC-6 and all the way forward through to PC-13. Thus, 6 scales across occurs in PC-4 and PC-5, and also in PC-14 and PC-15. That leaves PC-2 and PC-3, and also PC-16 and PC-17 with 4 (because the longitudinal flank row is absent anterior to PC-14, and thus the rules of contiguity change).

So, on the Figure 1 *C. mindorensis*, PC-1 has 5, PC-2 has 4 (with a minor internal anomaly), PC-3 has 4 (slightly wider than PC-2 was), and then the carapace widens further to 6 scutes in PC-4 and PC-5, and to 8 in PC-6. The drawing shows PC-7 with 8 scutes, plus a flanker on the right side (which does not count). As a general rule, PC-1 through PC-9 have the same counts in *C. mindorensis* and *C. porosus*, but from PC-10 to PC-14 the Philippine endemic has more scales per row than the Indo-Pacific Crocodile has (Ross and Mayer 1983: Table 1). Further, the same table reported zero as possible in *C. porosus* in PC-15, PC-16, and PC-17, and always in PC-18.

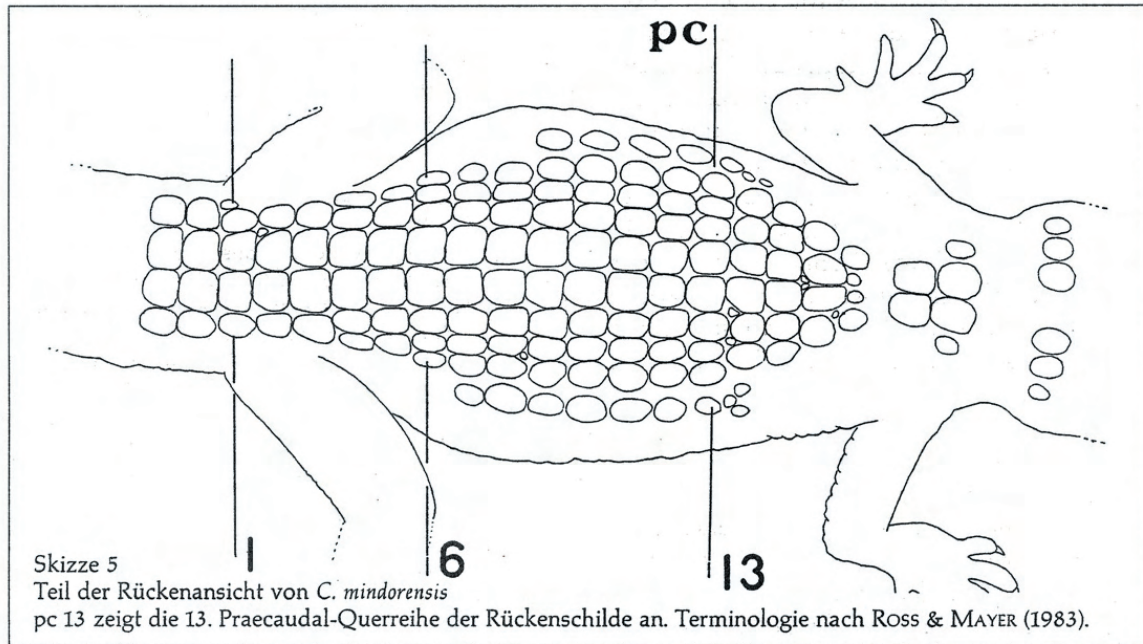


Figure 1. Rio Aoki's dorsal view of a *Crocodylus mindorensis* specimen.

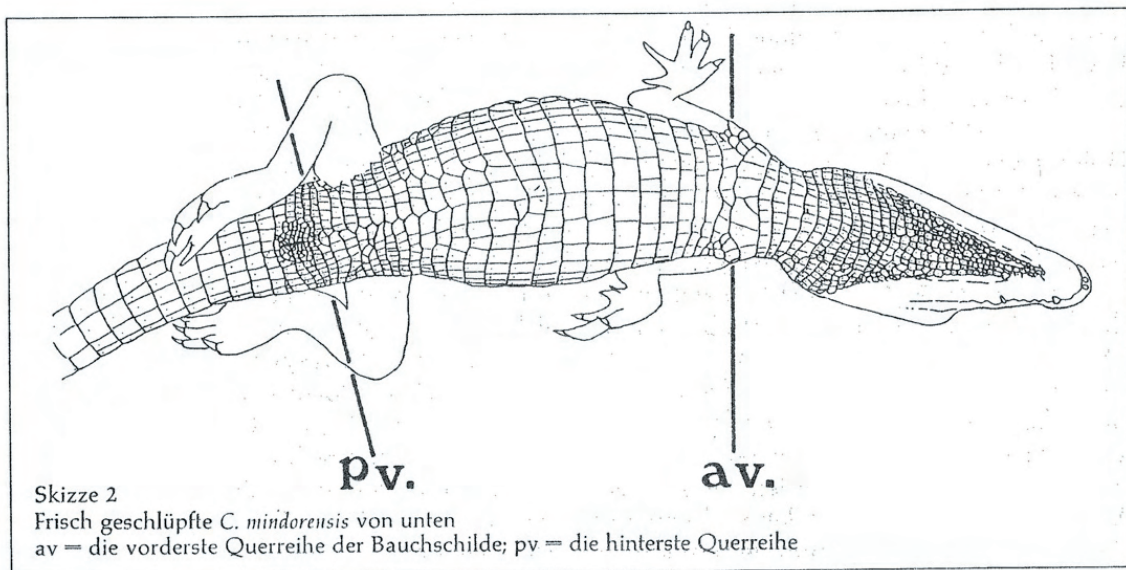


Figure 2. Rio Aoki's ventral view of a *Crocodylus mindorensis* specimen.

Note that the two tiny scales at the posterior edge of the right side of PC-12 in Figure 1 are interscute triangles, which occur in both species, but are strongly developed and more ubiquitous in *C. porosus*. Further note that the Ross and Mayer (1983) sample had only 5 Philippine *C. porosus* out of a total 12 for the species. The exact range of variation in the carapace armor of "salties" from the Philippines remains unknown.

Difficult as it is, the dorsal armor makes more sense than the belly scales, because in the former we know how many transverse rows of scales is ancestral for the crocodile. It is always PC-1 to PC-26 (or PC-27-?) possible. The number of rows is the number of vertebrae. In contrast, there is no known vertebral correspondence on the precloacal ventrum. The postcloacal ventral caudal “whorls” are usually continuous with the dorsal caudal rows, but this is not true on the belly and throat (including the collar). Therefore, there is nothing to do except counting the number of so-called “transverse rows” of scales between the collar and the vent (the C-V count) in Figure 2.

Counting the ventral scales involves seeing everything; and, like many of his other excellent illustrations (he figured the neonate nape of *C. porosus* compared with *C. mindorensis*, and also detailed some caudal scalation differences), this drawing (Figure 2) from Aoki (1985) is as good as a photograph. However, truly ventral view illustrations often do not show the lateral midbelly edges of the properly ventral kind of scales that are arranged in transverse rows. Note that within these rows the elements have the theoretical potential of their osteoderms suturing together, and each scale fills the height of its row (if it takes two scales to fill the row, they are not “ventrals” but are flank scales).

Unfortunately the belly scalation is not strictly bilaterally symmetrical, and there are often small midline anomalies. Different people count the collar-vent series differently. As detailed below, Andy was in the habit of counting the C-V number along the midline, but I prefer to make two counts, one slightly (about one full scale away) to the left of the midline, and one slightly to the right of the midline, and then calculate the average. The posterior end of the C-V count is always extremely small scales, and it is usually difficult to see exactly which transverse row is the first to pass anterior to the cloacal disturbance. In Figure 2, one scale to the left of the midline (from his “pv.” to his “av.”), I count 25 C-V rows, and on the right side (again one full scale away from the midline) I see 26 C-V rows, and thus the average is 25.5 rows crossing the midline. This kind of difference between the left and right sides is frequently encountered, and given the common ambiguity about which row is the posterior end of the series, one person’s C-V count can easily differ slightly from another person’s result. Depending on interpretation of where the cloaca stops and the belly scales start, 24 left and 25 right for an average of 24.5 could be correct in Figure 2. It is possible that counting along the midline will yield the same result as the pair of parallel counts, but often the midline count is higher, caused by midline anomalies.

In Figure 2, the 12th “row” posterior to the collar has one big scale on the immediate left-side of the midline, while on the right-side its place is occupied by two scales, one of which is roughly triangular. The advantage to performing the C-V count approximately one full scale away from the midline is that it avoids this problem. Similarly, the midline is a zigzag like a zipper in the region between the hind limbs. The left and right halves of the “rows” in this zipper zone are slightly offset from each other, and trying to count the number of transverse rows that cross the midline gets nasty.

In theory, the opening of the cloaca is surrounded by a roughly circular “cloacal oval” zone of tiny and irregularly shaped special scales. When I look carefully at Figure 2, the vent opening (the black longitudinal slit) seems to have the row that Aoki marked as the posteriormost qualifying ventral body row (“pv.”) too close to the slit, and it is possible that if I had the physical specimen in hand, I might select the row immediately anterior to Aoki’s row as the posterior end of my collar-vent count. Still, though, it is approximately 25 C-V rows.

Note that Aoki’s indication lines for the anteriormost transverse row in the C-V count (“av.”) do not extend far enough to reach the midline region where the collar-vent count happens. The collar that separates the throat scales from the belly scales is clearly discernible on this specimen. It has a triangular midline anomaly in it, and the more rectangular scales near its middle are longer than they are wide. Some species have less obvious collars. The roughly triangular shaped group of 7 or 8 small scales at the proximal end of the forelimb (where Aoki’s arrows actually point) are neither collar scales nor the first post-collar row. They are something special, and are completely excluded from the CITES collar-vent count.

The collar region in Figure 2 looks exactly like the collars that Andy and I found most common in the New World species of *Crocodylus*. It is hard to see, but Aoki’s drawing shows essentially every ventral scale (except the cloacal oval and except the triangular midline anomaly in the collar) as having a single pore centered in the posterior third of it.

Conclusion. Some C.A. Ross words about counting ventral scales

At the Smithsonian Institution in Washington, D.C., my brother Andy is famous for his stamina and efficiency at reducing avian carcasses to their skeletal elements. It was guessed by one of his supervisors that Andy skeletonized somewhere between 600 and 800 birds in a single year. Later, building on his work in the Division of Birds, and building on his earlier work reducing manatee carcasses to bones for the US Fish & Wildlife Service in Gainesville, Florida (where he became friends with James Perran Ross of CSG fame), Andy was given the opportunity to design and then hold the directorship of the USNM’s marine mammal skeletonizing facility. An anecdote from Charley Potter (courtesy of George R. Zug) is as follows: “One of my best remembrances of Mr. Ross was his sitting at the fume hood with the sash all the way up (= hood not working worth a damn), smoking a cigarette while washing bird bones with gasoline... gasoline all over the

place, the whole place reeking of gas, no gloves, etc., and when I said Hello, he said ‘What the fuck do you want?’ and then complained about working conditions... in the new lab... which by the by he did have a significant role in designing etc.” The paper by Von Endt *et al.* (1999) resulted from Andy’s work as a preparator of bird bones.

With Ross (1977a, 2008a,b) as exceptions, it is a general rule that Andy’s publications were not written in the first person (except sometimes Acknowledgments). The pronouns “I” and “we” are scarce, as are “my” and “our”. Therefore, as my conclusion, the following quotation is from a typewritten letter (to me at the Museum of Comparative Zoology at Harvard University) dated 4 February 1988 (from Andy at the US National Museum of Natural History).

“I have indeed looked at a lot of *Crocodylus* bellies recently and in fact had call to look at alligatorid bellies briefly as well.

“In brief, the collar is of little use as a diagnostic character, other than the fact that it exists, and as such gives an end or starting point for counting other scales. Lateral collar scales are at best difficult to determine. The median collar scales are perhaps of use by relative size, ie, twice as large or subequal to surrounding scales. Otherwise they are an end point in counting throat scales from the mandibular symphysis. My counting of throat scales goes from the anteriormost ventral scale, normally a single scale, found just posterior to the junction of the mandibles, to the last scale anterior to the collar. I will normally count this three times and take the average count as the value used for analyses. Alligatorids have lower throat scale counts than *Crocodylus*, and within *Crocodylus* the counts are relatively uniform except for mainland southeast Asia *C. siamensis*, which have a 20% higher count than any other species (or ‘*C. siamensis*’ from the Indonesian islands). This fact has not yet been mentioned in the literature, and I intend on publishing it within the next year or so depending on travel. In this paper will be a summary of throat scale row counts for all recent crocodilians.

“Transverse ventral scale rows I count from the row adjacent to and posterior to the median collar scales to the last transverse row anterior to the vent, and as close as possible to counting down the midline. This does not include the scales which encircle the vent, or any partial rows lateral to the vent. Albeit this is an arbitrary point to stop counting, but it is fairly easily defined, even if biologically incorrect. Again depending on the sample size (for the day) I will either count once or 3 times per animal.

“Within Indopacific crocodiles the best use of ventral scales is to split the ‘large scale’ from ‘small scale’ species, ie *C. porosus*, *C. palustris*, and *C. siamensis* (small scale species) from what I am considering a species group, *C. mindorensis*, *C. novaeguineae*, *C. johnsoni*, *C. raninus*, and *C. wabi* (ms. name). This difference in ventral scales is well known in the skin trade, ie Singapore small scale = *C. porosus*.

“*Crocodylus cataphractus* also has these large ventral scales but differs from the Indopacific group in other ways.

“In the past I have also counted the number of longitudinal ventral scale rows. I counted these across the belly at the level of the 10th transverse row posterior to the collar. This count has not been of particular use and is sloppy for the same reason as counting collar scales or lateral dorsal scales. Where do you stop/start laterally?

“...all my best, Sincerely, Charles A. Ross, Museum Specialist”

Postscript. Eureka! Attention CSG: those missing and damaged cloacas on flat ventral skins can now possibly cease to be an unavoidable problem

The most difficult and exasperating (confounding and subject to interpretation) part of the collar-vent count is its posterior ending point, and also the region between the hind legs (see Figure 2). The qualifying transverse rows of ventral scales tend to be very small near the cloacal disturbance, and additionally the immediately precloacal skin is often partly removed during the skinning process. Locating and identifying the exact posterior end of the CITES collar-vent (C-V) count is difficult on whole animals, and can be impossible on many commercial ventral hides. Further, the ventral scalation between the hind legs can be damaged and obscured on stuffed specimens and hornback hides.

Something that I had hitherto overlooked is an important improvement on the “large scale” versus “small scale” dichotomy from Alcalá (1986). Rather than counting the transverse rows of ventral scales located between the collar and the cloacal vent, Alcalá (1986) stopped counting when he reached the functional (transverse scale row) level of the anterior edge of the hind legs. The anterior end of the Alcalá (1986) count was called the “axilla” (the armpit), and it is possibly (we are here entering somewhat uncharted waters) the row immediately posterior to the collar, but I believe that it is ordinarily (or possibly always) the second postcollar transverse row that actually reaches the axilla in the living crocodilians (a testable hypothesis).

What Alcalá (1986: 52-53) said was that in *C. porosus* “the ventral plates are moderate, 23 to 30 between the axilla and the hind limbs” while, in comparison and contrast, *C. mindorensis* has “very large ventral plates, 16 to 18 between the axilla and the hind limbs” and, thus, there is no overlap of the ranges of variation in the two kinds of Philippine crocodiles. One has 23-30, while the other has 16-18.

In Figure 2 (Rio Aoki’s ventral view of a *Crocodylus mindorensis* specimen), starting the Alcalá count on the last transverse row before the start of the back leg, and counting forward one full-scale away from the midline, I see 16 rows, plus one additional row located just before the collar, on the left side. Separately, on the right side, again starting at the anterior edge of the rear limb, and then moving inwards towards the midline, and then going anteriorly, I count sixteen scales, plus the row that is immediately posterior to the collar. So, it has 16 or 17 Alcalá rows, depending on interpretation of the anterior end of the count. The Figure 2 animal from the Philippines is correctly identified (Alcalá’s prediction was 16 to 18). The Dalupiri Island animal shown in ventral view in the CSG Newsletter [24(3): 14] appears to have the same Alcalá count as Aoki’s specimen.

Note that Peters (1964) defined “axilla-groin” as “a standard measurement often used in herpetological taxonomy: the distance in a straight line from the posterior margin of the forelimb insertion to the anterior margin of the hindlimb insertion. Syn.: interlimb length” (diagrammed in his Figure 29 on a salamander and on a lizard), with “axilla” meaning “the armpit; the cavity beneath or behind the insertion of the anterior appendage”; and, Peters (1964:) defined “groin” as “the angle formed by the anterior margin of the hind limb and the body; the slight depression or cavity at the insertion of the hind limb. Syn.: inguen” and the noun “inguen” was defined as the groin, and the differently spelled adjective “inguinal” means “pertaining to or located in the groin” (p. 165).

The Alcalá (1986) axilla to groin count of midventral (long axis) region transverse rows is not a straight line between the actual axilla and the actual groin, but rather is roughly parallel to that line. Unfortunately the remarkably clear photograph of the ventral scalation of a *C. raninus* from Kalimantan in Ross *et al.* (1998) has the back legs pressed against the body in the inguinal region, and thus the precise level where the groin occurs is not identifiable. However, this photo is suitable for performing the CITES collar-vent count, and I see 22 rows on the left, and 23 on the right, for an average 22.5 result. The Ross and Alcalá (1983) collar-vent count prediction for Philippine *C. porosus* was 29 to 34 scales (average 31.7 rows crossing the midline), so the Ross *et al.* (1998: 76, Fig. 3) illustration is definitely not *C. porosus*. Rather, the 22.5 result agrees much more closely with the Ross and Alcalá (1983) prediction for *C. mindorensis* (22 to 25, average 23.9). When I compare the 1998 photograph (*raninus*) with my Figure 2 drawing from Aoki (1985), the region between the back legs on the 1998 *C. raninus* has significantly larger scales than those in *C. mindorensis*, but in both cases the sample size is small.

To avoid confusion, it is important that an author explains if the midline method, or alternatively the parallel pair of counts method produced C-V results. Separately, whenever Angel Alcalá’s axilla to groin count of transverse rows “crossing” (so to speak) the ventral long-axis midline is reported, the results should not be confused with C-V counts. Further, there is the additional question of whether the Alcalá (1986) count is performed along the actual midline, or alternatively one scale away on the left and right sides (I recommend the latter).

Finally, please note that in the most recent CITES identification manual (Charette 1995), the (key, page 4) ventral view drawing of a theoretical crocodilian lacks bilateral asymmetry in the collar-vent region (an extreme rarity, or possibly nonexistent), and the C-V count is shown as being a single series down the middle (along the midline). Thus, C-V results made the CITES way may slightly differ from my pair of parallel counts. My parallel method follows King and Brazaitis (1971). There is no information in any of the publications by Karlheinz Fuchs about whether he counted along the midline, or the alternative “parallel” method.

My brother performed the C-V count the CITES way, but I strongly prefer the 1971 method of “parallel” counts to the left and right sides a full scale away from the midline. The “parallel” counts are not actually truly parallel to each other (they diverge anteriorly), but the level of exasperation is lessened. I do not recall ever seeing a crocodilian belly that was truly bilaterally symmetrical. In the embryo the left and right sides develop independently, and thus, the midline is an ontogenetic development. The American Alligator, for example, can have an umbilicus scar that sometimes makes counting the CITES way impossible. The only good news is that, although it needs work at the “collar” end, and although it requires locating the anterior edge of the attachment of the hind limb (perhaps this is not a problem on flat commercial ventral skins), the Alcalá (1986) armpit to the hind limb count of ventral transverse rows of scales avoids the troublesome region between the back legs, and this long-axis interlimb-zone character avoids the ambiguity about where the cloacal oval stops, and simultaneously where the count from the vent to the collar begins.

Setting Peters (1964) aside, the word “groin” has an informal meaning involving the genital region. Especially in humans, the groin can be the space between the legs, as opposed to the anterior and lateral surface where the thigh meets the abdomen. The term axilla-groin, especially when referring to a midline-region count, could possibly be misinterpreted.

The original wording (Alcala 1986: 53 “between the axilla and the hind limbs”) is clear in one sense, but we are really talking about the midline region.

The Alcala (1986) counting method deserves consideration by the IUCN for future CITES identification guides, because flat ventral skins that have had their cloacal region cut out of them are commonly traded internationally, and it is often not possible to know if, or to what degree, the immediately precloacal midline-region belly skin is partly missing. So, you find the front edge of one back leg, and locate the transverse row that laterally extends to the true groin (the first one that is anterior to the groove where the thigh meets the abdomen). Then, follow that row towards the midline, and then (one scale before the midline) make a 90° degree turn and perform the longitudinal count going anteriorly towards the collar (and repeat this process on the other side). The collar row does not count, nor does the sometimes peculiar transverse row immediately posterior to it. The anteriormost qualifying transverse row is the one that actually reaches the axilla (armpit). The functional result is that the former single row of collar scales has become a complex of two collar rows, plus the roughly triangular-shaped and laterally placed zone of extra and irregular scales sandwiched between these two rows. The F.D. Ross interpretation of the ventral inter-forelimb phenomenon now goes all the way across (from one front-leg upper-arm attachment to the other), and the ventral interarm scalation-complex somewhat resembles the shape of an hourglass turned on its side. The two ends are usually thicker than the middle. The traditional collar is the second transverse row (counting near but not actually on the exact midline) anterior to the row that ends at the thoracic surface of the axilla. The transverse row that distally terminates on the trunk at the armpit is the interaxillary row (New Term: connecting one axilla to the other). The transverse row that distally terminates on the trunk at the groin can be called the intergroin row (New Term: connecting one groin to the other). The Alcala (1986) method is really the interaxillary and intergroin inclusive series, because the interaxillary row and the intergroin rows are both included in Angel’s long-axis interlimb series. These two newly named rows count in this quicker and more repeatable (collar and vent avoiding) count.

In this new alternative to the traditional C-V model of CITES, the intergroin transverse row (the “groin row”) replaces the cloacal oval (vent). The interaxillary transverse row (the “axillary row”) replaces the remarkably enlarged posteriormost “throat” (the traditional interpretation) row (the gular collar). The collar stays the collar, but is newly understood as being one of two transverse rows (that cross the midline), plus lateral (distally sandwiched) triangles of extra scales that all collectively constitute the ventral interforelimb scalation phenomenon. Assuming that the interforelimb zone overlies the paired clavicles (the collarbones), we now have a gular (throat) zone, a clavicular zone (between the front legs, and now including the collar), and finally a postclavicular zone that begins with the axillary row. That (the preaxillary region) is one important part of the ventral skin possibly mapped.

Someone should do some dissections to find out if “clavicular” is appropriate for the ventral interforelimb zone. The term “postclavicular” is quicker than post-interforelimb. How does the sternum relate to the collar? Something very basic is happening, and it happens remarkably consistently among the living Crocodylia. The very old fossil *Protosuchus richardsoni* did not have an ossified collar, but it did have a distinctly postclavicular plastron of rectangular osteoderms sutured together as transverse rows crossing the midline. These rows were themselves sutured to each other. The remarkably rigid protosuchian plastron posteriorly stopped at or near the umbilical zone, and thus probably did not reach the groin row.

Would somebody please define the umbilical zone (its range of rows in various taxa) in terms of its relation to the intergroin transverse row, etc. There should be a solution to this puzzle (where is the *Protosuchus* plastron on the modern crocodile?). However, be forewarned that the analysis above has not dealt at all with the “single-button” versus “double-button” ventral osteoderm dichotomy. The *P. richardsoni* plastron was illustrated and discussed in Colbert and Mook (1951), and they also informed us that the tail whorls on their remarkably well preserved fossil had two zones (one “dorsal” and the other “subdorsal”) of caudal osteoderms. The dorsal transverse tail rows had a “vertebral segmentation” (one row corresponding with each underlying vertebra), and the subdorsal transverse rows exhibited a “demivertebral segmentation” (two rows of caudal osteoderms for each caudal centrum).

The protosuchian caudal armor was separated from the subdorsal tail scales by a thin horizontal space of granular and thus flexible skin. The dorsal rows were twice as numerous as the subdorsal, and each subdorsal transverse row was approximately equal in size to its neighbors. It was not the modern “double-button” phenomenon in which there are two osteoderms inside one scale, and the anterior osteoderm is considerably smaller in length (but not width) in comparison to its posterior osteoderm mate. Again, something complex but probably real is going on here. The ventral scalation has baffled me for many decades. Do any of the living crocodilians have both single-button and double-button ventral scales? Are there four buttons in a stack (Ant.-Post. thin, thick, thin, thick) in the central pair of enlarged scales of the collar in the 1974 and 2006 picture of a *Paleosuchus* skin from K. Fuchs? [also available in the 1983 CITES manual].

In both Ross and Mayer (1983) and Aoki (1985) there are drawings that show the dorsal caudal armor separated from the subdorsal caudal armor by a horizontal zone of granular skin in the basicaudal area (also illustrated in one of Bill Magnusson’s SSAR *Paleosuchus* accounts). In the fossil *Protosuchus* this phenomenon continued along the entire length of the tail.

The ventral and ventrolateral special basicaudal postcloacal scalation in *C. moreletii* is, in extreme cases, two transverse rows of scales within one vertebral segment. The caudal whorl has two scales of equal size below, and one big scale above, and in Morelet's crocodile the basicaudal dorsal segmentation extends and continues to some extent onto the lateral basicaudal surfaces. Thus, somewhere (and irregularly, in a more or less fashion) on the sides of the tail the segmentation switches from vertebral to demivertebral.

There is considerable taxonomic variation in the size and shape of the throat scales as they approach the collar. In some taxa they remain small and somewhat granular, while in other taxa these posterior "gular" scales gradually form into clear transverse rows of rectangular scales and thus closely resemble collar scales in some aspects of size and shape. I think that the traditional "gular collar" is not a true gular row. The CITES collar is the first postgular row.

The subdorsal scalation, including detached longitudinal rows of osteoderms on the flanks of the trunk (see Figure 1), remains not yet understood. Note that embryologically, the detached lengthwise "rows" of enlarged and potentially ossified flank scales are adjacent to the continuous dorsal armor, and only become distinguishable from it ontogenetically, although before hatching. Some taxa have multiple flank rows, and it is often subjective about how many "rows" there are, and at what points they start anteriorly and stop posteriorly, or visa versa. The embryo crocodile curls around its yolk, and at a certain developmental stage the animal's outer surface (its "dorsal body armor region from PC-1 to PC-18) has the dorsal and flank scales (together as a single phenomenon) looking very much like the parallel-sided lengthwise strip (or stripe, like a paved walkway) in *P. richardsoni* (Barnum Brown).

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National Scenario of Crocodile Conservation in the Philippines

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Abstract

The Philippines has two species of crocodiles: the endemic Philippine Crocodile (*Crocodylus mindorensis*) and the widely distributed Saltwater Crocodile (*Crocodylus porosus*). Both species are nationally and globally protected under domestic laws and international agreements. Both species are threatened with extinction. The IUCN-SSC Crocodile Specialist Group (CSG) recognized *C. mindorensis* as the most threatened species of crocodile in the world. The report presents the Philippine Government's initiatives to save the species from extinction. It briefly discusses the national laws and policies, existing programs/projects and partnerships to conserve and protect both species. These include the passage of the Wildlife Resources Conservation and Protection Act (RA 9147); the establishment of the Crocodile Farming Institute (CFI), now known as the Palawan Wildlife Rescue and Conservation Center (PWRCC); commercial and sustainable use of *C. porosus*; and other *in-situ* and *ex-situ* conservation activities on both species, in collaboration with both local and international partners.

Philippine Crocodile Conservation in NE Luzon: an Update and a Proposal for a National Philippine Crocodile Reintroduction Strategy

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Abstract

The critically endangered Philippine Crocodile *Crocodylus mindorensis* is limited in distribution to isolated sub-populations in Mindanao and northern Luzon. Effective conservation of these wild populations, combined with reintroduction of the species in historical distribution areas is necessary to prevent extinction in the wild. Since the discovery of a remnant population in the municipality of San Mariano in Isabela in 1999, we implemented a conservation project here successfully engaging local communities in crocodile conservation. The killing of crocodiles decreased and 5 crocodile sanctuaries were established. The crocodile population is increasing, aided by a nest protection and hatchling head-start program. Positive experiences with community-based crocodile conservation and reintroduction of head-started crocodiles in San Mariano led to a pilot project to release 50 captive-bred sub-adult crocodiles in Dican Lake in the Municipality of Divilacan, Isabela in 2009. Monitoring of these crocodiles shows that there are issues with adaptation leading to high mortality rates and human-crocodile conflicts. The lessons learned in San Mariano and Divilacan, experiences elsewhere with crocodile reintroductions and the results of genetic studies can be used to design and refine the national Philippine Crocodile reintroduction and conservation strategy.

Distribution and Status of Crocodiles in Agusan Marsh, Eastern Mindanao, Philippines

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Abstract

This report contains the result of an exploratory survey conducted in Agusan Marsh Wildlife Sanctuary from November 2011 to March 2012, in the mid-section of Agusan River Basin in Eastern Mindanao, which presents crocodile distribution and condition of the marsh as to crocodilian habitat. Day exploration, night spotlighting and key interviews of informants indicate that the marsh supports extant population of crocodiles, but which are considered remnant and declining. One of the highlights of this survey was the discovery of two remaining habitats that may contain healthy populations of crocodiles in the marsh. Large number of crocodiles were not observed, which might form a viable breeding population in known rivers and lakes. The present distribution, based on current sightings and verified reports, are documented.

Introduction

Two species of crocodiles occur in the Philippines, the Indo-Pacific or Saltwater Crocodile (*Crocodylus porosus*, Schneider 1901) which is widely distributed in the Indo-Pacific region from southwestern India to northern Australia and Papua New Guinea (Ross and Alcala 1983), and the Philippine Crocodile (*Crocodylus mindorensis*, Schmidt 1935), also known as the Mindoro or Philippine Freshwater Crocodile), which is endemic to the country.

The most common and widely distributed *C. porosus* is found in almost all recognizable estuarine and freshwater habitats in the Philippines (Ross 2008). In the early 1980s it was reported to exist in large number in major bio-geographic regions in the country, such as Luzon, Negros-Panay, Mindanao and Palawan. However, due to the continued destruction of its habitats for agriculture and aquaculture projects, and uncontrolled hunting for its valuable hide, wild populations have been severely reduced (Ortega 1996) and the species is now extremely rare in the wild (Mercado 2008). Crocodiles in the Philippines are also considered vermin and the probability of their survival in the wild is low (Messel *et al.* 1992).

The Philippine Crocodile population came into science in 1935 when Karl P. Schmidt, curator of herpetology of the Field Museum of Natural History of Chicago, discovered the species on the island Province of Mindoro, thus it was named *Crocodylus mindorensis*. Forty-seven (47) years after its discovery, Charles A. Ross of the Smithsonian Institution, estimated its remaining wild population to be between 500-1000 mature individuals in 1982. Currently, it has been reported to exist in some areas of Ligawasan Marsh, Agusan Marsh and Pulangui River, Bukidnon Province, and all of the Island of Mindanao. Some was found in Northern Luzon in the areas of San Mariano, Isabela in Northern Sierra Madre Natural Park; Tineg, Abra in Cordillera Region; and Dalupiri Island in Babuyan Channel (Ortega 1998; Hibaya *et al.* 1999; Pontillas 2000; Manalo 2008; Oliveros 2008). But due to population reduction and decline in area of occupancy, extent of occurrence and/or quality of habitat (CSG 1996a), it is now considered as one of the most endangered crocodilian species in the world.

On the other hand, *C. porosus* are found in small numbers in some wetland habitats on a number of Philippine islands - especially Mindanao and Palawan. Their number is exceeding low and now considered to be in hundreds. It is doubtful that any wild populations exist that are large enough to sustain ranching or any other form of sustainable use (Messel *et al.* 1992). Based on Crocodile Farming Institute (CFI) acquisition records from 1987 to 1998, a total of 9 *C. porosus* individuals were caught and acquired from Agusan Marsh, Agusan Del Sur as part of its nucleus captive breeding population (CFI 1999).

With the successful propagation of both species of crocodiles in captivity by the Philippine Government project through CFI, the Protected Areas and Wildlife Bureau (PAWB) as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Management Authority in the Philippines, have granted the Project to use *C. porosus* for commercial breeding purposes in order to sustain its conservation. Both crocodile species are included on Appendix I of the CITES and are legally protected in the Philippines.

Further, in 1993 IUCN-SSC Crocodile Specialist Group (CSG) recommended that a renewed effort should be made to establish an innovative crocodile sanctuary for *C. mindorensis* and *in-situ* protection of *C. porosus*. This would result in safety net population of these crocodiles in the wild and in the long-term could form a base for crocodile ranching by local people. The CFI Project shares the CSG position and recognizes the urgency of this matter, considering the rapid human population growth leading to the destruction of wetland habitats due to population encroachment competing for the much needed wetland fauna habitat and habitat fragmentation.