

awareness level in students on role and importance of crocodilians as a keystone species in aquatic ecosystems. Follow up conducted after two months of workshop suggested that majority of students had retained most of the knowledge gained during the workshop. They were able to discuss scientific method in their classroom and meetings of eco clubs. Similarly, students were able to advocate and promote crocodilian conservation in their class rooms, eco-clubs and home.

- b. Syllabus: We developed a syllabus for this workshop. We believe this syllabus is replicable in any part of the world to include any crocodilian species. Additionally, the syllabus is flexible and can easily be tailored to fit the educational level of the target participants.

We consider our project to be important for two different yet interrelated reasons. First and foremost, our project contributed in capacity-building of high school students from one of the remote areas of Nepal by providing them an opportunity to learn and apply scientific method using crocodilians as models. Secondly, in this learning process students are expected to start appreciating crocodilians and develop positive attitude towards them which is critical to ensure long-term conservation of these globally threatened crocodilians. Based on the feedback on the workshop received from participating students and principals from both schools, this workshop appeared to a simple yet effective approach to build scientific knowledge in students and promote crocodilian conservation.

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## Zoos

### USA

SUCCESSFUL REPRODUCTION OF THE SUNDA GHARIAL (*TOMISTOMA SCHLEGELII*) AT AUDUBON ZOO. Despite being kept by many zoological parks over the past century (Niekiisch 2010; Stuebing *et al.* 2015), successful captive reproduction in the Sunda Gharial (*Tomistoma schlegelii*) has been rare, occurring at only a handful of zoological parks and crocodile farms in North America, Europe and Asia (Lilleor *et al.* 1995; Shwedick 2000, 2006; Shwedick and Sommerlad 2000; Whitaker 2000; Sommerlad and Baur 2004; Brazaitis and Abene 2008; Kardon and Muscher 2008; Matthew *et al.* 2010; Anon 2013; Stevenson 2017). As a long-time participant of the Association of Zoos and Aquariums' (AZA) Species Survival Plan for the species, *T. schlegelii* has been a flagship species of Audubon Zoo's Herpetology Department since the species was first acquired in 1986. After experiencing many years of producing non-viable eggs from a single pair of adults (ages unknown, but male and female have been in captivity for at least 45 and 44 years, respectively) maintained outdoors year-round at its reptile house, viable eggs with developing embryos were first received by the zoo in 2010 when one egg hatched prematurely - the hatchling perished in the incubator.

Over the last decade, several husbandry changes were made that are believed to have helped achieve and improve breeding success. Diets were modified to include more whole prey items and less muscle meat, and the male's weight was reduced to help improve fertility and aid with copulation. Additionally, incubation temperatures were increased and the handling of eggs during incubation was reduced. The first successful hatching of the species at Audubon Zoo

occurred in 2014 when two live offspring were produced. Subsequently, one hatching was produced in 2016 and two hatchlings in 2017. Most recently in September 2018, 7 *T. schlegelii* were hatched from a clutch of 21 eggs, making this the fourth successful hatching event for this species at the zoo and the greatest number of offspring produced there to date.

A total of 21 eggs were laid by the female in a nest mound comprised predominantly of live oak leaf litter on 25 June 2018. The following day, 10 eggs were retrieved by staff and set up for artificial incubation at 32.7°C. Approximately one month later, on 2 August 2018, an additional four eggs were retrieved from the nest and transferred to the same incubator. The remaining seven eggs were left to incubate naturally within the nest. Eggs retrieved from the nest (N=14) averaged 8.4 cm (range 7.9 to 9.3 cm) in length by 4.9 cm (range 4.5 to 5.7 cm) in width and had an average mass of 165 g (range 140 to 180 g).



Figure 1. First pipped *T. schlegelii* hatchling.

The first egg in the incubator pipped on 18 September 2018 after 84 days of incubation (Fig. 1), followed by an additional four eggs over the next four days. The hatchlings took 1-3 days to emerge from their eggs after pipping, and although all five individuals did show signs of some residual abdominal yolk, the degree of their abdominal distension was substantially less than what had been observed in previous years' offspring. Live hatchlings from these artificially incubated eggs averaged 104 g (100 to 106 g) in weight, 14.3 cm (13.5 to 14.7 cm) snout-vent length (SVL) and 29.8 cm (29.2 to 30.4 cm) total length (TL). Artificially incubated eggs that did not hatch deteriorated and were discarded at various stages throughout incubation, with five of these revealing dead embryos and other signs of development upon dissection.

While excavating the nest on 11 October 2018, to determine the fate of the eggs left to incubate naturally, two live hatchlings were discovered in the exhibit with the adults. These animals were leaner in appearance than their artificially-incubated siblings and did not show any of the same signs of residual abdominal yolk, averaging 100 g in mass (92 to 108 g), 16.0 cm SVL (15.4 to 16.5 cm) and 32.7 cm TL (30.7 to 34.7 cm). Original plans to study the parental behavior of *T. schlegelii* with offspring hatched naturally within the nest were suspended due to increased aggression observed between the male and female that began just days before the hatchlings were discovered on exhibit. All seven offspring were transferred to an off-exhibit enclosure where they are currently being reared together as a group. No aggression between siblings has been observed to date.

Together with recent hatchings at San Antonio Zoo (San Antonio, USA) in 2016, and Crocodiles of the World (Brizenort, UK; Stevenson 2017) and Zoo Miami (Miami, USA) in 2017, successful hatchings of *T. schlegelii* at Audubon Zoo over the past several years represent a continuing trend of successful captive reproduction of this species in zoological parks which follows decades of marginal and inconsistent breeding success. At the institutional level, this recent hatching event represents a marked increase in egg viability and hatch rates. Most notably, this event may represent the first time that *T. schlegelii* eggs have successfully been hatched naturally outside of the species' range states. A more detailed and thorough report describing the history, husbandry and reproduction of *T. schlegelii* at Audubon Zoo is forthcoming.

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## Europe

3RD EUROPEAN CROC NETWORKING MEETING. The 3rd European Croc Networking Meeting was held on 5-7 October 2018 at La Planète des Crocodiles in Civaux, France. With the backdrop of a nuclear power plant and sky walks over crocodile-filled ponds, it was a location to remember. We had 49 participants from 11 countries, representing husbandry, research, fashion and industry, as well as hobbyists and enthusiasts.

Key talks in husbandry covered the first captive Gharials hatched in Europe (Mira Procházka) and the Chinese alligator status in Europe and China (Eddy Even). We followed up with research being conducted by Paris Zoo in French Guiana (Oliver Marquis), PhD work on Gharials in Nepal (Phoebe Griffith), how fossil Gavialids diversified (Polly Russell), and a quick overview of the diversity of crocodilian research (Ashley Percy).

The speed dating was unique as always, giving the participants a further opportunity to mingle and exchange ideas. We brought forth opportunities in Europe and around the globe for internships, volunteer and graduate programs. If any of

you would like to be added to our ever-growing list, please feel free to contact us.

We also had our first poster session, which we hope will expand. Congratulations again to Cedric Orlando for winning our best student poster on the morphometrics of the inner ear. He made an additional request for inner ears when doing autopsies or dissecting animals. Please email him for the protocol ([cedric.orlando@hotmail.fr](mailto:cedric.orlando@hotmail.fr)). We try to promote collaboration wherever possible- your help would be really appreciated.

The 4th European Croc Networking Meeting will be held at the National Reptile Zoo in Kilkenny, Ireland, on 4-6 October 2019! We hope to see you all there!

Ashley Percy, Agata Staniewicz and David Oudjani - *The 2018 Organizing Team*.



## Submitted Publications

### Observations of deep-diving in Nile crocodiles (*Crocodylus niloticus*) in Lake Tanganyika, Tanzania

Over the course of two 10-month filming expeditions to Lake Tanganyika in 1990 and 1992, stationed on the shores of Mahale National Park, Tanzania, the authors observed adult Nile crocodiles (*Crocodylus niloticus*) diving to depths in excess of 30 m, and recorded a tethered juvenile diving to a depth of at least 60 m. On several occasions, white polypropylene net floats used to mark cichlid nest sites were found punctured in the recesses of underwater caves on a boulder slope at depths of 15-25 m. The puncture marks were consistent with bites from 2-4 m long *C. niloticus*.

On at least 3 occasions divers encountered individual Nile crocodiles (3-4 m TL) underwater at Lubugwe, a deep-water inlet where depths of 100 m exist within 30 m of the shore. A crocodile, estimated at 4 m TL, was observed motionless with its head in a small cave at a depth of 15 m on the north side of the inlet. On two subsequent occasions when trying to film crocodiles on the south side of the inlet, 3-4 m long individuals dived actively into deep water and were recorded swimming rapidly down at a depth of 30 m, before divers lost sight of them.

These observations prompted an experiment in which a captive juvenile (0.8 m TL) Nile crocodile was fastened in a lightweight nylon harness, tethered to 25 kg test monofilament line, and released with a maximum recording depth gauge (Oceanic, analogue, 0-200 feet) attached to it, in around 75 m of water (checked with depth sounder) (at 6° 10' 04.08"S, 29° 44' 21.92"E). On release the crocodile headed down and then remained motionless for 40 min. It was then retrieved, alive and very active, with the depth gauge indicating a depth attained of at least 60 m - the gauge's limit.

It is hoped these limited observations will stimulate further study into deep-diving in crocodilians.

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