of an adult male) in 2008, and 5 adults (inclusive of an adult male) in 2013. The 2015 finding throws new light on numbers of this critically endangered crocodile in CNP. The crocodile population in CNP, in areas where Gharial and Mugger are sympatric, is estimated to be ~145 individuals [90 Gharial (62%) and 55 Mugger (38%)].

The project is being undertaken in collaboration with the Uttarakhand Forest Department and CTR. Valuable support has been provided by Columbus Zoo, CZS CBOT Endangered Species Fund, PPG Conservation and Sustainability Fund, as well as an Asia Seed Grant from Cleveland Metroparks Zoo. The supporting NGO is The Gadoli and Manda Khal Wildlife Conservation Trust and The University of Stellenbosch, South Africa, is the associated academic institution.

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SALTWATER CROCODILE PROJECT IN BHITARKANIKA OF ODISHA, INDIA: A SUCCESS. With initiation of the Government of India/FAO/UNDP Project "Crocodile Breeding and Management" a Crocodile Conservation Project was launched in 1975 in different states of the country. The Gharial (*Gavialis gangeticus*) and Saltwater crocodile (*Crocodylus porosus*) conservation program was first implemented in Odisha in early 1975. Subsequently, the Mugger (*Crocodylus palustris*) program was initiated, since Odisha has the unique distinction of having all three species of crocodilians.

Conservation and Research Centres were established by the Forest Department, Government of Odisha, at Tikarpada (Satkoshia Gorge Sanctuary), Dangmal (Bhitarkanika Wildlife Sanctuary/National Park) and Ramatirtha (Similipal Wildlife Sanctuary) for Gharial, Saltwater crocodile and Muggers, respectively. The main objective of the program was to quickly increase the populations using "grow and release" techniques. During the last 39 years the 'rear and rehabilitation' of crocodiles at various centres has been carried out successfully.

Studies have also been carried out to determine the appropriate method of population assessment, egg collection, egg incubation, hatching and husbandry of young crocodiles and various aspects of behavioural biology of the three species and their habitat features.

The *C. porosus* program is more of a success than the other two projects in the state. At a national level it is on the top as far as "rear and release" as well as building up of the depleted wild population is concerned. The population in the Bhitarkanika River system has gradually been built up over the last 40 years. The annual census conducted in the river systems of BWS/NP in January 2015 indicated that there were 1665 *C. porosus*, including more than 200 adults, and the population is still increasing. Density has increased from 0.87/km (1976) to 12/km (2015).

The annual census results indicate:

1. Successful implementation of the Saltwater Crocodile 'rear and rehabilitation' program in BWS/NP since 1975.

2. There has been a marginal increase (1.26%) in the crocodile population since the January 2014 census.

3. Successful nesting of wild and released crocodiles (about 70 nests were located in different parts of the sanctuary during the 2014 nesting season - more than 13 times as many as were recorded in the mid-1970s).

4. Kanika Range holds 75.3% of the current population.

5. Bhitarkanika has 10 crocodiles 16-18' in length, 6 at 18-20' and 3 at about 20'.

6. The areas (main Bhitarkanika River from Khola to Pathasala, Thanapati, Mahinsamada, Suhajore and Baunsagada Creeks, Kalibhanjadia, etc.) which have the higher concentration of crocodiles have the following characteristics:
   (a) Good mangrove cover/fringing mangrove vegetation;
   (b) A network of creeks and creeklets;
   (c) Plenty of fish as food;
   (d) Stretches of undisturbed mud banks as favoured basking/resting spots;
   (e) Less human disturbance (no illegal fishing activities);
   (f) Hypo-saline condition of water in the river and creeks; and,
   (g) Depth of water (2 m at the lowest tide in the major creeks/creeklets).

At present, Bhitarkanika holds the largest wild *C. porosus* population within the species' distribution in India, and about 80% of the total Indian population represented in the Bhitarkanika River systems of Odisha State.

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Europe

Germany

INDUCED NATURAL BREEDING OF THE PHILIPPINE CROCODILE (*CROCODYLUS MINDORENSIS*) AT THE COLOGNE ZOO. Since the first breeding of the Philippine crocodile in Europe, at Cologne Zoo in Germany (Ziegler *et al*. 2013), further breeding successes in Europe occurred in the Czech Republic (Protivin Crocodile Zoo), the UK (ZSL London Zoo) and Denmark (Krokodille Zoo). Due to these recent breeding successes and the inclusion of Protivin Crocodile Zoo into the European Studbook (ESB) the number of Philippine crocodiles within the ESB has increased from 15 sub-adults to 53 individuals, of which 29 are juveniles (Ziegler and Rauhaus 2015).

In February 2015, the two adult Philippine crocodiles at Cologne Zoo again showed interest in each other and were brought together for mating. Mating activities continued up to April 2015. Due to continued target training with the Philippine crocodiles at Cologne Zoo (Rauhaus and Ploetz 2014), individuals could easily be separated and thus mating activities controlled. By doing so we could invite the media on 19 February to show courtship and mating behaviours (approaching, tactile stimulation, bubbling and finally copulation) (see also Schneider *et al*. 2014).

Increased nesting activities of the female were observed during April, and egg deposition finally took place on 17 April 2015. Eleven eggs were laid, of which two were malformed and one destroyed. Of the remaining 8 eggs, 4 were left in the nest in the exhibit and 4 were transferred to two incubators, where two were incubated at "high" temperatures (31.5-31.9°C) and two at low temperatures (29.0-30.2°C). The eggs left in the nest did not show any signs of development, and the two eggs incubated at high temperatures hatched on 6 July 2015, after 80 days of incubation.

In contrast to Ziegler *et al*. (2013) we did not hear hatchling calls first, but found one hatchling penetrating the eggshell with its snout. We then played hatchling calls recorded from our first breeding success in July 2013 to encourage the hatchlings to answer, and after about 15 minutes the "pipped" hatchling and the unhatched animal started calling.

To facilitate both the mother and the hatchlings to live out natural social behavior we decided to transfer the eggs into the nest to induce natural hatching and to document mother-offspring interactions. We locked the female by using the target into a separable part of the enclosure, and placed the two hatching eggs together with the two eggs incubated at low temperatures inside the nest in the exhibit. We decided to place all the eggs from the incubators at the same time into the nest because we did not want to disturb the female a second time with another egg transfer.

When the slide gate was opened, the female entered the part of the enclosure with the nest, but initially remained for some time in the water in front of the nest. We replayed the hatchling calls from above the nest to stimulate the two hatchlings, which subsequently answered, and the female approached the nest. She approached the eggs and tactually scanned them with her snout; afterwards she started with the mouth transfer. The first hatchling, which had meanwhile emerged entirely out of the egg, escaped her first attempts to pick it up and she first carried the empty eggshell into the water, where she carefully opened it by breaking the shell with her teeth. This happened both above the water surface and under the water (here with closed eyes). Then she again approached the hatched animal, which remained on the top of the nest. The hatchling then started calling again and actively turned its head towards her mouth, so that the female could pick it up and carry it into the water after some failed attempts.

After a while she approached the second egg, took it into her mouth and carried it into the water, where she opened it the same way she had done with the first eggshell. By gently crushing the eggshell between her teeth under the water surface the juvenile swam out of her mouth towards the land part and rested there. So as not to disturb the mother and offspring interactions we in fact had blocked the enclosure from visitors from the beginning. As the Philippine crocodile couple held at Cologne Zoo is kept separated except for the mating season, the male had neither access to female nor to the nesting enclosure. In the latter enclosure we could record nest guarding behavior of the female including attacks towards the zoo staff standing at the visitor's side of the public enclosure which observed the events in the nest enclosure. During the next days mother and offspring interactions were peaceful and the mother stayed in immediate vicinity of the young.

As the two remaining eggs, which had been incubated at lower temperatures did not hatch during the following 7 days we decided to control the nest another time on 13 July 2015. We locked the female into the other enclosure and took the two eggs out of the nest. At that time the eggs we noticed that they were deeper into the nest relative to how we had buried them, so the mother must have covered them with further substrate. One of the eggs showed a rupture, but the hatchling obviously was not able to cut the eggshell membrane. This may be due to the changed climatic conditions, once being taken out of the incubator. We assisted by opening one side of the eggs before placing them back into the nest, on the 87th day after egg deposition.

Both hatchlings were in a relatively weak condition and did not call. After having let the female inside the nesting enclosure, we had replayed hatchling calls to attract the female towards the eggs in the nest. The female immediately began with the same behavior as was we had observed before. When the female had opened the eggshell of the third hatchling in the water, the emerging hatchling remained under water. With the mother locked away in the other enclosure we retrieved the hatchling by using a long dip net from above the enclosure, and positioned the hatchling on land. We then let the mother into the enclosure, but she ignored the moribund hatchling and finally stepped on it (and killed it) as she approached the other (fourth) hatchling inside the nest.

This dead hatchling had a total length of 24.3 cm, snout-vent length of 11.9 cm and weighed 53 g. The fourth hatchling was in better condition, having emerged from the egg and begin calling when the mother approached. After some hours it was moved by the mother towards the water, but it fell into the water before mouth transport could be accomplished.

From the following day on, all three hatchlings remained for most of the time close together on a flat land area in the enclosure, where the female occasionally approached them and continued with nest guarding behavior. One week after the third hatching event we opened the sliding gate between the female and nesting enclosures. From that point the mother increasingly moved from the young and the nesting enclosure during daytime for basking. The young remained hidden for most of the daytime. Feeding of the hatchlings during daytime could not be observed before 24 July, but we assume that they

Figure 1. (left) mouth transport; (centre) female crushing egg in the water of nesting enclosure with emerging young; (right) female guarding hatchlings. Photographs: Thomas Ziegler.

fed on offered crickets and earthworms during the night. The mother and offspring interactions were observed by our team by the hour and we currently are evaluating the data which will be presented in detail elsewhere.

This event represents the first successfully induced natural breeding of the Philippine crocodile in Europe. Based on this we could gather important and in part unknown data about the breeding and social behavior of this species, but also important information on how to keep the species in captivity. For example, the willingness of the mother to participate in the target training even with the freshly hatched young around her and thus the possibility to gently separate the female from the nest without interfering the breeding behavior provides important knowledge on handling the species in captivity during breeding. With our current knowledge it would have been no problem to leave the two eggs which had been incubated at lower temperatures inside the incubator and only inserting them into the nest later.

Now, with these many breeding successes in Europe in a relatively short period of time and after having had the chance to enable natural breeding in captivity, the main focus for the management of the Philippine crocodile conservation breeding will be the dispersal of the abundant offspring to other interested institutions and to build up suitable pairs in the future. As the parents of the European offspring have all been genetically screened as pure *C. mindorensis* (Hauswaldt *et al*. 2013; Ziegler *et al*. submitted), the offspring can also be considered as a valuable resource for future restocking projects in the Philippines.

This recent breeding success is dedicated to our dear friend Ralf Sommerlad, who passed away in June 2015, and who supported us so invaluably with building up of Philippine crocodile conservation breeding and target training at Cologne Zoo.

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East and Southeast Asia

Lao PDR

REDISCOVERY OF THE SIAMESE CROCODILE (*CROCODYLUS SIAMENSIS*) IN KHAMMOUANE PROVINCE, CENTRAL LAO PDR. The Siamese crocodile (*Crocodylus siamensis*) historically occurred over much of mainland Southeast Asia as well as parts of Indonesia. Its current distribution is greatly diminished and fragmented. Extant populations are in Cambodia, Indonesia, Lao PDR and Thailand; wild populations in Vietnam are possibly extirpated (Bezuijen *et al*. 2012). The Siamese Crocodile is listed on Appendix I of CITES, and is listed on the IUCN Red List

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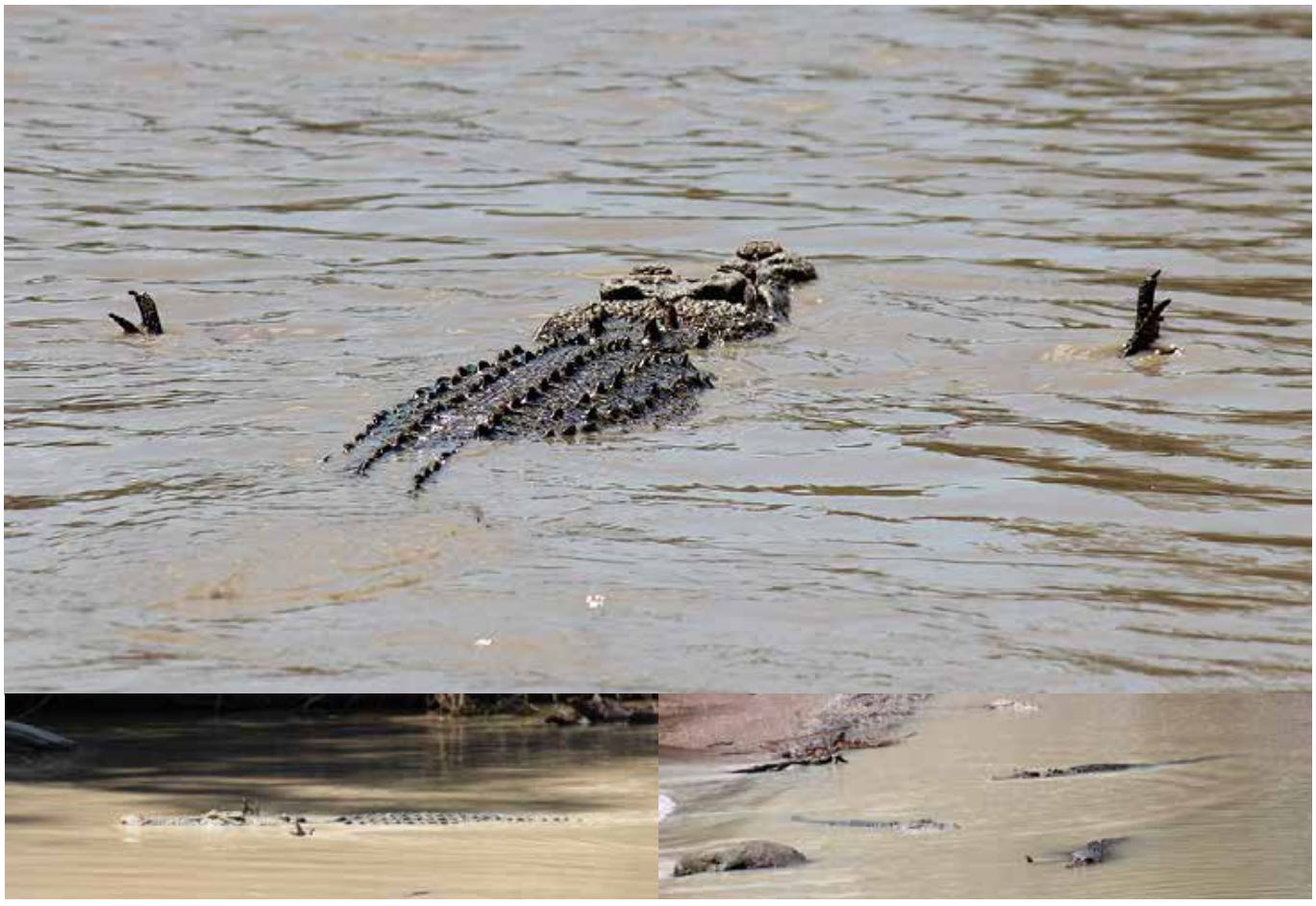

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