was held at the Clemson University Baruch Institute of Coastal Ecology and Forest Science in Georgetown, South Carolina. Eighteen speakers from a diversity of backgrounds gave presentations on alligator management, stressors and general biology, mostly focusing on South Carolina populations. Over 60 people, representing state and federal agencies, municipalities, private landowners, universities, and NGOs attended the symposium. Of special note, the three pioneers of alligator management and research in South Carolina - Mark Bara, Tom Murphy and Phil Wilkinson - were all in attendance, and the latter two made presentations.

The symposium was followed by a dinner/social at a rustic, outdoor locality where speakers and attendees slaked their thirst, sated their hunger, and continued conversations about alligator research, management, and conservation in a relaxed and jovial atmosphere. Plans for the next symposium are underway.

Figure 1. Speakers at the first Palmetto Alligator Research and Management Symposium. Front Row (L-R): Tara Gancos Crawford, Thomas Galligan, Thomas Rainwater, Stacey Lance, Russ Lowers, Phil Wilkinson. Back Row (L-R): Jim Glover, Tom Murphy, Shane Boylan, Matthew Hale, Matthew Hamilton, Jessica Tipton, Arnold Brunell, Abby Lawson, Jackie Bangma, Frannie Nilsen, Nicole McNabb, Jay Butfiloski. Photograph: Ben Parrott.

Figure 2. The three pioneers of alligator research in the state of South Carolina (USA). (L-R): Tom Murphy, Mark Bara, Phil Wilkinson. Photograph: Ben Parrott.

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# Europe

## Germany

PHILIPPINE CROCODILE (*CROCODYLUS MINDORENSIS*) TARGET TRAINING AT COLOGNE ZOO. In this report we provide a brief overview of our outcomes with Philippine crocodile target training at Cologne Zoo. The public enclosure, where 1.1 *Crocodylus mindorensis* are held, comprises ca. 70 $m^2$ and consists of three parts combinable by sliding gates, enabling visual, acoustic and olfactory communication (Ziegler *et al*. 2011). Due to intraspecific aggression, the pair is housed separately except during the mating season.

Since the opening of the public enclosure in 2011, target training is conducted for management reasons (eg pairing, enclosure shift, work safety) as well as for behavioural enrichment (Rauhaus and Ploetz 2014). The training, which was introduced to us by the late Ralf Sommerlad, follows the principle of operant conditioning. The crocodile has to fulfil a requested behavior on cue [eg approaching the target, consisting of a 3 m bamboo stick with a yellow ending (adhesive textile band)]. Afterwards we use an acoustic and/or tactile bridge as secondary reinforcer, before the crocodile is rewarded with a food item (primary reinforcer). The tactile bridge (stroking with the target over head and body) also desensitizes the crocodiles towards being touched (eg in the course of veterinary treatment), while the acoustic bridge (the word "good") serves for precise timing and is useful when we cannot reach it with the target. As food rewards, depending on individual preference and food demand, all small food items which can easily been taken up by the crocodiles and thrown by the keeper are suitable, as long as they are not too rich for daily use and the crocodiles do not get overfed. At first, we trained on fixed times (0700 h and 1500 h) to get the animals used to the training process, meanwhile we mostly practice one extended training sequence per day (as long as we do not establish a new command) and vary the times. Initially, we only conducted a few tasks per session to not overstrain the crocodiles; later on, we increased the length of the sessions and requested more tasks. Anyhow, we try to finalize each session positively for the animal, so we rather exercise less commands than too many.

Our first command was "here". The crocodile has to approach the target and touch it with its snout (Fig. 1) without biting inside. Afterwards, we say "good", stroke with the target over the head (Fig. 2) and reward the crocodile with a food item. As the crocodiles are conditioned that the food reward follows when they keep calm during the stroking, they meanwhile keep still when being stroked on every part of the body. As the crocodiles felt most safe in the water, the target was first placed into shallow water at the transition to the land part; subsequently we gradually increased the distance to the water. When the animals felt safe enough to completely come onto land, we also increased the distance to the target between the commands.

The second command was "water", which was introduced by

pointing with the target towards the water. Subsequently, the target was slowly faded out, so that after some days (female 6 days, male 10 days), the crocodiles moved into the water only by the acoustic cue. Next step was switching them between the enclosures (the female was locked in the nesting part; the male was called into the middle part to enter land section there, and afterwards back). As the crocodiles already had learned to follow the keeper's voice and the target stick, they soon swam quickly from one enclosure to the other on command. It was important to avoid any negative association with closing the slide gates, so for both animals opening and closing was a familiar situation, which also worked without water in the enclosure (during cleaning).

Figure 1. Female Philippine crocodile touching the target. Photograph: Thomas Ziegler.

Figure 2. Stroking female Philippine crocodile with the target after successfully performed command. Photograph: Thomas Ziegler.

Figure 3. Crate training: female Philippine crocodile follows the target towards the opening of the crate. Photograph: Anna Rauhaus.

Figure 4. Crate training: At first, female Philippine crocodile was guided inside the crate with the target being inserted through the upper crate opening; later on, the upper crate opening was closed and the target positioned at the opposite crate entrance. Photograph: Anna Rauhaus.

Another command was "up". Here, we used normal head lifting behaviour and tried to cue it by placing the target above the crocodile's head and saying "up". We practice this (eg when training a new command), as it is at rather low costs for the crocodiles, to avoid frustration by requesting and rewarding a simple task in between more difficult ones.

Since January 2015 we practice crate training to enable medical examinations or stress-free transports (Figs. 3 and 4). The crate has openings at the sides and on top, for habituating the crocodiles getting touched and treated there. In the beginning, we left the crate open. The first goal was to let a crocodile pass through the crate on command, to be later on able to close the slide gates and lock the crocodile inside. In the first training session, both crocodiles strongly reacted to the unfamiliar element (eg by increased "bubbling" in the water in front of the crate, not reacting to the target, or biting inside), but after they had the chance to explore the crate for some hours, in the second session both crocodiles moved through the crate with one rewarded stop in the middle and one at the end. After 3 weeks, both crocodiles

mostly immediately entered and passed through the crate on cue, and after 5 weeks, we could also make them enter and pass the crate from the other side. Meanwhile the target as visual stimulus for this exercise is almost completely left out and only the knocking of the target stick on the wood together with the command "box" is used to cue the entering and passing through the crate with only one reward at the end. In a next step, we will start to train closing the entrances of the crate for some time when the crocodiles are inside.

During mating, the training allows us to introduce and separate the animals in a controlled and stress-free way. Even in situations when aggressions occurred, we never had to intervene directly, because crocodiles can be called away from the other individual and subsequently swim into their enclosure part on command. After the first successful reproduction in Europe (Ziegler *et al*. 2013) we extended the training to the likewise solitarily kept juveniles, once they were habituated to the keepers and their enclosures and solidly feeding. We started to train the 5-month-old juveniles by introducing the target and the command "here". In the beginning, they were rather shy and stopped feeding for some days. But after few weeks they followed the target both on land and in the water.

In general, we found that not only species-specific, but also individual characteristics should be considered in developing the training. Patience and consequence are important in training crocodiles, as they for example often stop shortly before the target, but we always wait until it is actually touched. If the target is not approached after a period of waiting, we rather place the target further distant so that the crocodiles recognize that they have to further invest to reach the reward. In case of not requested behavior, we avoid negative feedback like saying "no". We only leave the reward and wait or give the command somewhat later again. If after some attempts the animal still does not show the requested behavior, we use another command or in the worst case interrupt the training session and come back later ("time out"). We try to avoid generating too much noise with the target not to address an instinctive prey reflex but training a given cue. If training is done by several persons, consistency in cues and reinforcers is crucial. We also found that training pauses of several days do not affect the success in longer-time trained animals, but should be avoided in the first phase of new commands.

It seems to be of importance to stay variable in training duration as well as in command order and rewards. For example, if exercises are always trained in a consistent sequence, crocodiles start to offer the respective behavior on their own, without previous command. Furthermore, we do not always start with the same animal and have no signal which finishes the session. We also do not use a steady number of commands and rewards per session and try to alternate high and low value rewards in an unpredictable manner as well as the level of difficulty in the commands. The most time intensive aspect seems to build up trust. Once the target and the voice of the keeper are positively associated, new commands can be established quite fast. As important element in modern animal training, the crocodiles always have the choice to participate in the training and can leave it at any time. One indicator that they seem to enjoy the training is that the Philippine crocodiles participate in the training even after larger food portions have been consumed, and when only insects are offered as rewards. Thus, the form of rewarding seems to have less priority than the activity itself. Furthermore, since we started the training, the crocodiles never left the session without return. We could notice that the Philippine crocodiles are much calmer and less nervous since we started the training; they also built up a bond with the training keeper (eg strongly react to his voice). As further positive secondary effects we observed an increase in activity and use of space during day time, also before and after the sessions.

The behaviour of the female during the induced natural breeding in 2015 also clearly showed that the training also works and is accepted under exceptional circumstances. Although we had to switch the female several times between the sections of the enclosure and by doing so had to separate her from the hatchlings, she immediately continued with the parental care after the training and did not show any signs of stress caused by the disturbance (Ziegler and Rauhaus 2015). Besides eased work sequences and a secured and stress-free crocodile handling, the training is also important for the so far often disregarded crocodile enrichment. By doing so, the enclosure surface is better used by the crocodiles during daytime and visitors benefit from active crocodiles and get a better understanding of their intelligence and learning aptitude.

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