# BIAWAK

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# On the Cover:
## *Varanus bengalensis*

The illustration appearing on the cover of this issue depicts *Varanus bengalensis*, and originates from Plate 101 (Tab. CI) of Albertus Seba's monumental 1734 work entitled, *Locupletissimi Rerum Naturalium Thesauri*. Identified by Seba as "Lacerta", this early account and illustration of *V. bengalensis* predates Linnaeus' 1735 *Systema Naturae*, which introduced the concept of binomial zoological nomenclature. Moreover, this work also predates the first application of *Varanus* Merrem 1820 to varanid lizards by more than eighty years.

Seba's *Locupletissimi Rerum Naturalium Thesauri* remains an important and highly sought after illustrated work, particularly due to its large emphasis on herpetological natural history. Several additional illustrations depicting varanid specimens from Seba's personal collection appear throughout the work, including *V. salvator* and *V. niloticus.*

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# BIAWAK

*Journal of Varanid Biology and Husbandry*



**INTERNATIONAL VARANID INTEREST GROUP**
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The International Varanid Interest Group is a volunteer-based organization established to advance varanid research, conservation, and husbandry, and to promote scientific literacy among varanid enthusiasts. Membership to the IVIG is free, and open to anyone with an interest in monitor lizards and the advancement of varanid research. Membership includes subscription to *Biawak*, an international research journal of varanid biology and husbandry, and is available online through the IVIG website.

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*Varanus salvator macromaculatus* eating a turtle egg. Japanese Gardens, Singapore. Photographed by **Ken Goh**.

# NEWS NOTES

## 641 Monitor Lizards Captured in Thailand

A total of 641 Asian water monitors (*Varanus salvator macromaculatus*) were captured in Samut Songkhram's Amphawa District, Thailand by officers of the Department of National Parks, Wildlife and Plant Conservation due to complaints by villagers. Local villagers claim that the lizards had been raiding numerous fishery farms. The lizards are to be released in the Khaoson Wildlife Breeding Centre in Ratchaburi's Chom Bung District.

*Source: Bangkok Post, 10 July 2013***.**

*Varanus tristis*. Ayers Rock, Northern Territory. Photographed by **Dean Lee**.

## Charges Filed for Monitor Lizard Poachers in India

Forest Department Officials in Chandrapur, India filed charges against six individuals, including five police officers in a case of monitor lizard poaching (species not identified, but likely *Varanus bengalensis*). The men are accused of delivering 2 kg of monitor lizard meat to a local restaurant.

*Source: The Times of India, 6 July 2013*

## Two Arrested with Golden Monitor Lizard

The Central Investigation Bureau of the Nepal Police arrested two wildlife traders that were in possession of a golden monitor lizard (*Varanus flavescens*) in Kathmandu, Nepal. The suspects were caught by police as they attempted to sell the live animal to a potential customer. It was later determined that the animal was captured in Taplejung before it was brought to Kathmandu for sale. *Varanus flavescens* is protected in Nepal under Annex 1 of the National Parks and Wildlife Conservation Act of 1973, and the illegal trade in the protected species brings a steep fine and a jail sentence of 5 to 15 years.

*Source: The Himalayan, 26 July 2013*

## New Monitor Lizard Exhibit to Open at the Bronx Zoo

Exhibit artists at the Wildlife Conservation Society's Bronx Zoo (USA) are putting the finishing touches on a brand new exhibit which will display several species of monitor lizard including *Varanus komodoensis*, *V. macraei*, *V. mertensi*, and *V. acanthurus*. This will be the zoo's first time displaying *V. komodoensis* since the 1950s.

*Source: The New York Times, 15 July 2013.*

## Komodo Dragon Population Around Pota in Decline

The population of Komodo dragons (*Varanus komodoensis*) in the vicinity of Watu Payung Lake, Pota, Flores is in decline due to the effects of poaching. Local residents have taken to trapping the animals which they blame for attacks on their livestock. The population has only been known to the outside world since 2011 and as the region does not constitute part of Komodo Park, authorities consider their conservation status to be of high concern. Local villagers professed that they were unaware the large lizards were the same as the park's namesake species.

*Source: Jakarta Post, 29 June 2013*

## Television Star Pleads Guilty to Sale of Protected Monitors

Donald Schultz, a self-described reptile expert and television personality on the Animal Planet series *Wild Recon*, has pled guilty to charges connected to the sale of two Iranian desert monitors (*Varanus griseus*). The animals, along with a number of other reptiles, were listed for sale on Schultz's Facebook account. An undercover agent with the U.S. Fish & Wildlife Service contacted Schultz claiming to be purchasing the animals for a third party. A sale was eventually completed and the pair shipped to another agent in New York in 2010. The sale of the endangered desert monitors, protected under Appendix I of CITES was in violation of the Endangered Species Act, and can bring up to one year in prison and a $100,000 fine.

*Source: Los Angeles Times, 13 September 2013; 19 November 2013*

## Losses for Zoo Komodo Dragons

Komodo dragons (*Varanus komodoensis*) at two U.S. facilities have recently died. A 20 year-old male Komodo dragon was euthanized at Zoo Atlanta. A zoo spokesperson said Slasher, who had hatched at the National Zoo in 1992, was euthanized to due undescribed age-related complications. At the San Antonio Zoo, a female dragon died along with five other reptiles when a fire broke out in the complex. The fire, believed to have

*Varanus komodoensis*. Rinca, Indonesia. Photographed by **Frank Yuwono**.

been the result of an electrical malfunction, started in the zoo's Komodo House and was eventually contained by firefighters, but not before some losses. It is believed the five-foot dragon died of smoke inhalation. Zoo officials have said that, as of now, the Komodo exhibit will be closed indefinitely.

*Sources: Atlanta Journal Constitution, 5 August 2013 (Zoo Atlanta); Chicago Tribune 16 December 2013 (San Antonio)*

## Connecticut Police Shoot and Kill Nile Monitor

Ledyard, Connecticut (USA) police shot and killed a 'large' Nile monitor (*Varanus niloticus*) that had escaped into the small community. Police and animal control responded to a report from a resident who claimed an "alligator" was raiding her chicken coop. Police claim they killed the animal to prevent further risk to livestock and, despite an obvious lack of reason, human life. The specific origins of the animal are not known, though it is believed to be an exotic pet that had escaped. Officials noted that such animals are illegal to possess in the state of Connecticut. Ledyard officials had received numerous reports of escaped monitor lizards throughout the summer, though it is not known whether they were all due to this single animal or not.

*Source: The Norwich Bulletin, 26 August 2013*

## New Komodo Dragon Population Discovered on Flores

Researchers have utilized camera traps to confirm the presence of a population of Komodo dragons (*Varanus komodoensis*) in the Mbeliling Forest region on the island of Flores. The population is in the vicinity of the villages of Golo Mori and Tanjung Kerita Mese; an area said to be experiencing current environmental and social problems. No population estimates have yet been worked out, though based on morphological observations of the viewed dragons, it is believed to number at least five animals. The discovery suggests that other small populations of the species may remain to be discovered along the coast of Flores. The studies were conducted by Burung Indonesia, the NTT Natural Resources Conservation Center (BKSDA) and Komodo Survival Program in July and September.

*Source: Jakarta Post, 11 December 2013*

## Two Monitor Lizards Seized in Shut-down of Crocodile Farm

Authorities in Moscow, Russia have shut down a "crocodile farm" at an exhibition center in the city due to suspicion that the reptiles on display have been smuggled into the country. The exhibition's owners failed to provide CITES paperwork confirming the legal acquisition of the facility's specimens. A total of 134 crocodiles, 10 snakes, an iguana, and two monitor lizards (species not identified) were seized from the facility. No further details were given regarding where the animals were transported to.

*Source: www.en.ria.ru, 15 July 2013*

## Annual Meeting of the AG Warane und Krustenechsen

The 2014 annual meeting of the AG Warane und Krustenechsen will take place at the Leipzig Zoo from 17-18 May 2014. All talks will be in German. The program is listed below. Due to organizational reasons registration is requested until the end of April. Please

contact Thomas Hörenberg (hoerenberg@ag-warane.de) or André Koch (andrepascalkoch@web.de).

*Day 1: Saturday, 17 May 2014*

10:00 Reception: Thomas Hörenberg & André Koch
10:30 Markus Patschke (Bochum) & André Koch (Bonn): Systematics of the *Varanus timorensis* Group
11:00 Yannick Bucklitsch (Cologne) & André Koch (Bonn): Scale structure of monitor lizards and their systematic value
11:30 Lunch break
13:30 Fabian Schmidt (Leipzig): Keeping Komodo dragons at Zoo Leipzig
14:15 Members Meeting
14:45 Coffee break
15:30 Tino Meyer (Altomünster): Keeping and breeding *Varanus mertensi* (not yet confirmed) Alternate: Thomas Hörenberg (Esslingen): The monitors of the Subgenus *Odatria*
16:30: André Koch (Bonn): Comments on Hoser's disputed classification of monitor lizards

*Day 2: Sunday, 18 May 2014*

10:00 Guided tour through the reptile facilities of the Leipzig Zoo including the new Komodo dragons.

The new Gondwanaland exhibit at Leipzig Zoo.

# Preliminary Announcement for an Interdisciplinary World Conference on Monitor Lizards

An interdisciplinary world conference on monitor lizards will meet in the Bangkok, Thailand area in late July 2015. Exact dates and other details are still being finalized, but the conference will take place during the last two weeks of July 2015. This early announcement is being made so that those requiring more than a year to acquire funding can start preparing.

Further details will be announced in the next issue of *Biawak*, which will be published in June 2014. Intentions to attend and inquiries can be directed to Michael Cota at Herpetologe@gmail.com.

# Komodo Dragons on Display Once Again at Frankfurt Zoo

For the first time in almost four decades, Komodo dragons (*Varanus komodoensis*) are on display at the Frankfurt Zoo (DE). The two females, sisters hatched at Los Angeles Zoo in 2011, arrived at the Frankfurt Zoo in August 2012, but have been maintained off display until recently. Both dragons currently measure 1.35 m in total length and weigh 5 kg.

*Source: http://fr-online.de, 10 October 2013*

*Varanus komodoensis*. Leipzig Zoo.

# ARTICLES

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# Shelter from the Storm: An Unconventional Refuge for a Wild *Varanus varius* (White, 1790) (Reptilia: Sauria: Varanidae)

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**Abstract – A wild adult *Varanus varius* was observed high on the external brick wall of an occupied residential dwelling in a rural landscape in eastern Australia prior to and during a heavy thunderstorm. This was a remarkable climbing feat for such a large heavy-bodied animal and illustrates the strong arboreal capabilities of *V. varius*.**

*Varanus varius* is distributed over much of eastern continental Australia and some eastern off-shore islands (Cogger, 2000). The species feeds on a wide range of arboreal and terrestrial prey, as well as animal carcasses (e.g., Metcalfe & Richards, 2009; Metcalfe & Jones, 2012, and references cited therein). Mature adult *V. varius* are Australia's largest extant endemic terrestrial predators by mass. Despite its large size, the species has well-developed climbing abilities. This note describes observations of a wild adult *V. varius* seeking shelter on the external brick wall of a house prior to an imminent thunderstorm.

Observations were made at 'Avocado Heights', a fruit-growing property located near Emerald Beach, New South Wales, ca. 26 km north of Coffs Harbour. A brick residential dwelling (Fig. 1) with several outbuildings are situated atop a concrete platform located in a leveled area near the top of a coastal hill that had been cleared of native vegetation and surrounded by exotic ornamental shrubs, small trees, gardens, and lawns (30° 09' 53.19'' S; 153° 09' 31.75'' E, datum: WGS84, ca. 65 m elevation). A fruit orchard exists on slopes below the buildings. The nearest native vegetation is in Orara East State Forest at the top and on western slopes of the ridge which adjoins the western and northwestern boundaries of the property. *Varanus varius* has been observed on the property for over two decades (Metcalfe & Jones, 2012, unpub. dat.), and is usually seen at least once a month during the warmer nine months of the year (Jones, pers. obs.).

Figure 1. Brick residential dwelling.

Figure 2. *Varanus varius* seeking shelter from a thunderstorm on the brick wall of a residence.

Around 1540 h on 11 February 2012, approximately five minutes before the onset of a short (ca. 15 minutes duration) but intense thunderstorm with heavy rainfall, the first author (AAJ) observed an adult *V. varius* (total length ca. 1.2 m) on the brick wall of the residence. It had climbed to the top of the three metres high wall and along the brickwork between the glass sliding doors and the eave. Upon the author's return with a camera, the subject had moved slightly further along the brickwork (Fig. 2), where it remained for most of the duration of the storm. When checked 2-3 minutes after the storm had passed and rainfall had ceased, the *V. varius* was gone. Prior to these observations, it was a hot (maximum $T_a$ = ca. 34° C) sunny day, but overcast skies developed in the afternoon about 30 minutes before arrival of the storm.

This appears to be the first record of a wild adult *V. varius* seeking refuge on the wall of a house, and demonstrates the arboreal tendencies of *V. varius* as well as its ability to overcome its typically shy nature when in close proximity to humans. When threatened, *V. varius* typically climbs large eucalypt trees, and usually rests at night on large limbs or hangs vertically from tree trunks (Metcalfe, pers. obs.). Although not as common a behavior, some animals may also seek refuge inside hollows of fallen trees, or in rabbit or wombat burrows, especially when pursued by humans (Metcalfe, pers. obs.). When it is raining, *V. varius* appear to cease all foraging activity and usually climb the nearest large tree (Metcalfe, pers. obs.). It is likely that the individual in the above observations was caught out whilst foraging in a treeless area by the approaching storm, and utilised the nearest elevated structure for refuge.

**Acknowledgments** - We thank Florance Jones for assistance, and anonymous reviewers for comments on earlier drafts of the manuscript.

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# Husbandry and Breeding of the Crocodile Monitor *Varanus salvadorii* Peters & Doria, 1878 in Captivity

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**Abstract - Due largely to its impressive size, *Varanus salvadorii* has become a mainstay in zoological exhibitions. Yet, despite its popularity in captive collections, little data exists on its husbandry and reproduction in captivity. This article describes experiences with the captive husbandry and breeding of *V. salvadorii* at two zoological parks in Madrid, Spain.**

## Introduction

Endemic to New Guinea where it inhabits dense lowland tropical forests, the crocodile monitor lizard *Varanus salvadorii* has rarely been observed in the wild (Horn *et al*., 2007). Wild populations of *V. salvadorii* are threatened by the effects of habitat fragmentation caused by uncontrolled logging and mining activities, as well as over-collection for food and the exotic pet trade (Koch *et al*., 2013).

Since 2001, the legal export of live *V. salvadorii* specimens from Indonesia to the European Union has been curtailed as a way of preventing declines in wild populations (UNEP-WCMC, 2009). However, some countries such as Spain, France, Germany, the Czech Republic, and the United Kingdom continue to receive wild-caught specimens by importing them via intermediate countries such as the United States (UNEP-WCMC, 2012). Given the continued demand for live specimens, breeding this endangered species in captivity may be one of the best options for reducing the number of specimens taken from the wild.

For many years, there have been limited data available on the successful reproduction of *V. salvadorii* in captivity (Philippen, 1994; Schmicking & Horn, 1997). Some earlier reports documented successful breeding behavior including copulation, oviposition, and even hatching, but most of the eggs received had been infertile. Until recently, successful reproduction of *V. salvadroii* in zoos had been limited to the Honolulu Zoo (1997-1999), Fort Worth Zoo (1997-1999), and Gladys Porter Zoo (1992), but in the last few years, some reports on the husbandry and breeding of *V. salvadorii* have presented interesting and promising results (Waterloo & Bayless, 2006; Mays, 2007; Trout, 2007), with the Denver (Trout, 2007) and Houston (Mays, 2007) Zoos successfully reproducing specimens in their collections.

In an effort to present useful information that can be used to increase captive breeding and reduce the capture and removal of specimens from the wild, this article describes husbandry and successful reproduction of *V. salvadorii,* in captivity.

## Care in Captivity

### *Naturaleza Misteriosa at the Madrid Zoo & Aquarium*

The Naturaleza Misteriosa at the Madrid Zoo & Aquarium currently maintains a breeding group of adult *V. salvadorii* in two adjoining enclosures each measuring

Figures 1 & 2. *Varanus salvadorii* terraria at Naturaleza Misteriosa at the Madrid Zoo & Aquarium.

3 x 1.5 x 2 m (L x W x H) (Figs. 1 & 2). The breeding group is currently comprised of one male (M1) (Fig. 3) and two females (F1 and F2). Females are housed together in a separate, adjacent terrarium from the male. Males and females are only introduced for mating purposes and housed together for periods of two to four weeks. Both females are rarely introduced to the male at the same time since female F1 has shown aggression towards the male and female F2. During introductions for breeding, the male or female is lured into the other sex´s enclosure with food to avoid handling and related stress.

The terraria are equipped with heated floors, an automatic misting system, ultraviolet lighting and a single basking area. Ultravitalux lamps (300W) are used to generate basking spots of 35-40° C. Ambient temperatures are maintained for most of the year at 28-32° C, decreasing slightly in the winter months. Humidity levels are increased from the months of May to August through four to six 3-minute misting sessions per day; humidity levels are kept lower during the remaining eight months of the year, with only two to three misting sessions daily. A 50-100 cm deep layer of cocopeat or coconut fiber is offered as substrate because of its ability to retain humidity. Live plants are avoided because they are immediately destroyed by the animals. Each enclosure features a dense area of thick branches and a large pool of water measuring 90 x 120 x 30 cm (324 L).

Figure 3. Male M1 in the terrarium

The diet offered to captives is quite varied, comprised mainly of poultry (chicken, chicks, quail) and rodents (rats, mice), but rabbit, duck, turkey, fish and crayfish are also offered on occasion. For behavioral enrichment, fresh or cooked eggs are sometimes buried in the soil, which are quickly found and unearthed. Young animals feed primarily on newborn rodents and small portions of poultry. Adults are fed twice weekly, and juveniles are fed two to three times per week. Food offerings are increased during the mating period.

*Parque Temático de la Naturaleza Faunia*

Several specimens of *V. salvadorii* have been maintained at the Parque Temático de la Naturaleza Faunia in Madrid, Spain since 2008. At the Parque Temático de la Naturaleza Faunia, up to 1.3 specimens have been housed together in a 5.5 x 2.5 x 3 m enclosure. The terrarium is equipped with an automatic misting system, ultraviolet lighting and two basking areas. Ultravitalux lamps (300W) are used to generate basking spots of 35-40° C. The enclosure also features a water

basin measuring 100 x 50 x 50 cm. A dense area of thick branches connects with two different resting rocks located 1.5 and 2 m from the floor. All other husbandry parameters are identical to those described for the Madrid Zoo & Aquarium.

**Behavioral Observations**

We have found the behavior of *V. salvadorii* in captivity to be particularly interesting. Captive specimens of *V. salvadorii* are typically nervous, elusive, and shy away from human contact, and some can even respond aggressively to human presence. As we have seen in other reptile species, each specimen of *V. salvadorii* has unique behavioral patterns that clearly distinguish it from other individuals. Through daily husbandry routines and human activity, all specimens at the Madrid Zoo & Aquarium have become very comfortable with human presence and rarely exhibit stress or assume defensive postures. The males are very curious and peaceful towards humans; two of the females are calm as well, but one female (F1) has remained highly nervous and irritable.

Adding new objects to the enclosures provides opportunities for the animals to investigate them, opening up a wide range of possibilities for behavioral enrichment. At the Parque Temático de la Naturaleza Faunia, a target training program has been developed to enhance the animals' physical abilities as well as enable veterinary procedures such as blood extractions and other treatments. Progress was slow, but some results have been achieved. Today, these captives are stronger, faster, and can be handled without any danger, even by veterinarians and strangers.

**Captive Reproduction**

*Madrid Zoo & Aquarium*

In April 2009, female F1 (Fig. 4) at the Madrid Zoo & Aquarium was introduced to the enclosure of male M1. Initially, both animals were tolerant of one another; however, by the end of the month, the female began to show signs of dominance and aggression towards the male. During this time, there were observed attempts by the male to copulate with the female, but successful copulation was not observed. Without definitive proof of successful mating, and with increased aggression by female F1, it was necessary to separate her from the male in the first week of May and move her back with female F2 (Fig. 5). In late June there were episodes of aggression by female F1 directed toward female F2; therefore, it was decided to house each female separately. For three days, female F1 refused food, which is unusual for the species and especially for this female. Gravid female varanids often refuse to eat, especially as egg laying approaches; sometimes they may accept food, but end up regurgitating it  hours later. These signs are often suggestive of imminent ovoposition.

On 2 July 2009 female F1 laid a clutch of 10 eggs, which were partially buried in the soil next to a fallen tree trunk. All eggs were removed and buried in a plastic container with vermiculite mixed with water to an approximate ratio of 1:1 by weight, and placed inside an incubator constructed from a modified refrigerator. Maximum and minimum temperatures inside the incubator were recorded every 12 hours; incubation temperatures ranged between 28 and 30.5° C.

By the second week of incubation, six eggs became

Figure 4. Female F1 in the terrarium.

Figure 5. Female F2 in the terrarium.

dark in appearance, showing signs of infertility. It was decided to move each egg to its own plastic container and isolate them from the remaining eggs which still looked viable. These six eggs were discarded some days later. After 185 days of incubation, the first two eggs hatched; a third egg hatched nine days later after 191 days. On day 200 the remaining egg was manually opened, as its appearance began to worsen. Inside the egg was a dead, fully-developed embryo, with an everted and deformed abdomen.

In late September 2009, female F1 was introduced to the enclosure of male M1, where they were housed together for a month. No successful copulations were observed during this period. The female did show aggression towards the male on several occasions, causing in some cases bite wounds that required veterinary care. Thus, it was once again necessary to separate the pair.

In early January 2010, female F1 laid a clutch of 10 eggs, which were scattered atop the substrate throughout the enclosure. The eggs were laid one at a time over the course of the night and following day. Incubation parameters were similar to the previous event, except that the eggs were incubated in individual containers from the beginning. After the first 15 days of incubation, six eggs were visibly darker and turgid, indicating they were not viable, and were discarded. The first two offspring hatched after 185 days of incubation (Figs. 6 & 7). Two additional hatchlings emerged two days later, resulting in a total of four healthy offspring.

Female F1 was introduced to the terrarium of male M1 on three different occasions in 2010. Two of these introductions in June and August lasted less than a day due to excessive aggression that the female showed towards the male. The third introduction lasted for one week during early September 2010.

During the first week of November 2010, female F1 laid a clutch of 10 eggs which were once again scattered throughout the enclosure. Unlike in previous events, digging behavior was not observed in the days leading up to oviposition. Eggs were incubated individually at temperatures ranging from 29.5-30.5° C. Eight out of the ten eggs showed signs of infertility after 15 to 21 days of incubation and were discarded. The two remaining eggs hatched after 155 days of incubation (Fig. 8).

Figures 6 & 7. *Varanus salvadorii* hatching, 2010. Photographed by **Jairo Cuevas.**

Figure 8. Hatchling *V. salvadorii* emerging from egg, 2011. Photographed by **Jairo Cuevas**.

Figure 9. Closeup of hatchling *V. salvadorii*. Photographed by **Jairo Cuevas**.

Figure 10. Hatchling *V. salvadorii* shortly after emerging from its egg. Photographed by **Jairo Cuevas**.

Figure 11. Juvenile *V. salvadorii* bitting a handling glove. Photographed by **Jairo Cuevas**

*Parque Temático de la Naturaleza Faunia.*

A group of one male (M2) (Fig. 12) and three female (F3, F4, F5) *V. salvadorii* have successfully lived together in the same terrarium at the Parque Temático de la Naturaleza Faunia for two years without any signs of aggression. In July 2010, male M2 began pursuing the females in an effort to copulate with them; copulation was observed between the male and all three females. In late August, one of the females (F3) began to dig in a hollow log filled with humid cocopeat, and deposited five eggs, of which only one was fertile. Over the next several days female F3 became lethargic and unresponsive. Veterinary radiographs confirmed the presence of a retained egg within the oviduct which required surgical removal. This female died on 1 September 2010 from complications related to the dystocia.

Figure 12. Male M2 at the Parque Tematico de la Naturaleza Faunia. Photographed by **Jairo Cuevas**.

The single remaining egg incubated for seven months at temperatures between 28-30° C before it began to deteriorate in early March 2011. Dissection of the egg revealed a dead, fully developed embryo.

Female F4 died in 2011 due to an ovarian cyst, reducing the *V. salvadorii* breeding group at Parque Temático de la Naturaleza Faunia to female F5 and male M2. In November 2012, the breeding female F1 from Madrid Zoo & Aquarium was transferred to the Parque Tematico de la Naturaleza Faunia due to problems with aggression directed towards male M1, the father of all offspring produced to date. In March 2013, this female was introduced to female F3 and male M2, but showed aggression towards the new male, so it was necessary to separate her from this new group. In early July 2013, male M2 began attempting to copulate with female F3, so it was decided to once again introduce female F1 to the group. Aggression was not observed between female F1 and the male, and copulations were observed over the next 10 days. In early August, courtship and copulations ceased. On 10 September, female F1 scattered a clutch of four infertile eggs on the soil surface without showing any apparent signs of nest-building.

**Discussion**

*Varanus salvadorii* is a difficult species to breed in captivity because very little is known about its biology. Some zoos have successfully bred this species, but the results have not always been as favorable as they could be. For example, infertile eggs, aggression, incubation difficulties, and reproduction-related pathologies are a

few challenges frequently experienced with this species. Based on our experiences with *V. salvadorii* at the Parque Temático de la Naturaleza Faunia and the Madrid Zoo & Aquarium, it is possible to develop a breeding program for *V. salvadorii* with groups of individuals maintained together all year long, or with groups of individuals that are housed together and only introduced during the breeding season.

Although individual *V. salvadorii* may experience difficulties adjusting to each other's reproductive cycles, temporary separation of the male may increase chances of successful reproduction when reunited with females during the mating season. Caution should be taken when females are housed together with males, as aggression can occur. It is possible that females respond aggressively to repeated attempts by males to mate with them throughout the year when they are not receptive. Our experiences suggest that aggressive behavior by the female towards the male is inhibited when females are reproductively cycling and receptive to copulation.

In North American captive collections, male and female *V. salvadorii* experience several hormonal peaks throughout the year which define the ideal time for reproduction (Long, 2005). While hormonal fluctuations occur throughout the year in males, females maintain a consistent pattern of estrogen peaks, especially during the months of January, March, June, July, and August. Ultrasound data from captive individuals indicated that estrogen peaks coincide with an initial phase of follicular growth which reaches its height one month after the beginning of vitellogenesis (Long *et al*., 1999). Thus, if these findings are applicable to captives held in other parts of the world, the months of February, April, July, August and September could be months when females are most fertile, and thus the months in which animals should be paired for breeding.

Our findings from Madrid generally agree with Long *et al*. (1999), but successful mating has also occurred in October. Higher temperatures and humidity levels, and longer daylight could be responsible for triggering the three distinct mating periods that have been observed in *V. salvadorii* at the Madrid Zoo & Aquarium (September-October and April-June) and one at the Parque Temático de la Naturaleza Faunia (July-August). These reproductive periods are likely reflective of the conditions inside the terrariums rather than the weather patterns or climate of Madrid.

This article adds additional information to what is known about the husbandry and reproduction of *V. salvadorii* in captivity. It is hoped that this information will be useful to other keepers and institutions seeking to keep and reproduce this species in captivity.

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# Notes and Observations on the Fish Prey of *Varanus salvator macromaculatus* (Reptilia: Squamata: Varanidae) in Thailand with a Review of the Fish Prey of the *Varanus salvator* Complex Known to Date

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**Abstract - The catching of fish by *Varanus salvator* and species of the *V. salvator* complex is documented along with a review of the literature. Observed capture and predation of Perciform and Siluriform fishes by *V. salvator macromaculatus* is herein described. Taxonomic clarification is made of the historical accounts on fish predation by *V. salvator* ssp. and the *V. salvator* complex, due to recent, significant taxonomic changes concerning *V. salvator*.**

## Introduction

For animals that spend much of their lives in or near the water, there is not a wealth of literature mentioning the live capture or even the eating of fish by monitor lizards of the *Varanus salvator* complex, which is currently comprised of several taxa (Koch *et al*., 2007, 2010) and has one of the most extensive ranges of any monitor species complex (Smith, 1932; Grandison, 1972: Losos & Greene, 1988; Traeholt, 1994b). This is even more surprising, considering that *V. salvator macromaculatus* is rarely, if ever found more than 200 m from water (Cota *et al.*, 2009), which is also probably true for other species of the *V. salvator* complex given their close relatedness (Koch *et al*., 2007, 2010). The first report of *V. salvator* feeding on fish was by Boulenger (1903), which appeared to be forgotten in subsequent literature until Grismer (2011). Deraniyagala (1931) appears to be the primary source that has been cited in the following accounts; however, the type of fish and whether it was alive or dead at the time of feeding was not specified. Deraniyagala's (1931) account deals with the nominate form, *V. s. salvator.*

In the past three decades, a wealth of literature has been produced on monitor lizards and their diets. In their comprehensive study on the diet of monitor

lizards, Losos & Greene (1988) mentioned fish, citing Deraniyagala (1931), but did not encounter fish within the diet of *V. salvator* specimens analyzed in their own study nor did they mention any other literature documenting fish in the diet of *V. salvator*. Losos & Greene's (1988) account deals with what is now the *V. salvator* complex.

Based on observations of five captive juveniles, Traeholt (1993) stated that *V. salvator* showed no signs of being able to catch live fish. Traholt (1994a) further noted that the catching of fish was documented by Deraniyagala (1931), Lim & Harrison (1957), Smith (1932), and Gaulke (1991), but noted that Gaulke (1991) reported that the fish were trapped in small shallow pools of water that were formed during low tide; Gaulke (1991) actually stated that the shallow ponds were formed during the dry season. The monitors in Taeholt's (1993, 1994a) accounts represent *V. salvator macromaculatus*, while those of Gaulke (1991) represent what are now known as *V. cumingi*, *V. marmoratus*, and *V. nuchalis*. Bennett (1998) also mentioned fish in the diet of *V. salvator* (which refers to the entire *V. salvator* complex), presumably citing Deraniyagala (1931). It should be noted that Smith (1932) did not mention the capture of fish by *V. salvator*, but included fish in a list of general dietary items of monitor lizards which also included birds and their eggs, small mammals, reptiles, crustaceans, large insects and sometimes carrion. Regarding *V. salvator*, Smith (1932) only mentioned that individuals of the species spend much of their time along the shore when the tide is out in search of crustaceans and mollusks. Smith's (1932) account refers to the nominate form, *V. s. salvator* and *V. salvator macromaculatus.*

Gaulke & Horn (2004) also cited Deraniyagala (1931), including fish as a dietary item of the nominate form of *V. salvator*, but did not mention fish in their dietary account for *V. salvator* ssp. (Horn & Gaulke, 2004), which, with the exception of *V. salvator andamanensis* which still retains subspecific rank, is now comprised of several species within the *V. salvator* complex. In his observations on *V. salvator* in North Sulawesi, De Lisle (2007) observed *V. salvator* on three occasions leaving a lagoon with a large fish (possibly *Mugil* sp.; Order Mulgiformes), but did not indicate how often or how they were able to capture the fish. De Lisle (2009) classified this form as *V. salvator ssp.* Referring to the *V. salvator* complex, Eidenmüller (2007) also listed fish as part of the diet of *V. salvator*, citing De Lisle (1996); however, De Lisle's (1996) account did not list fish as a prey item. Karunarathna *et al.* (2008a) documented *V. salvator* predation on *Hypostomus plecostomus* (sucker mouth catfish) in Sri Lanka. In a later publication, Karunarathna *et al.* (2008b) documented *V. salvator* feeding on *H. plecostomus*, *Oreochromis mossambicus* (Mozambique tilapia), *O. niloticus* (Nile tilapia) and *Osphroneumus goramy* (giant gourami), which were supplied by a zoo for consumption by aquatic birds. Both accounts by Karunarathna *et al.* (2008a,b) represent *V. s. salvator.* Amarasinghe *et al.* (2009) discussed *V. salvator* feeding on discarded fish and fish parts, referring to *V. s. salvator.*

Wickramasinghe *et al.* (2010) reported *V. s. salvator* displacing water from small ponds with the tail to catch fish (*Heteopneustes* sp. and *Puntius* sp.) as they were expelled onto land. Stanner (2010) reported *V. salvator* feeding on *Clarias* sp. (*C. batrachus* = walking catfish), *Fluta alba* (synonym of *Monopterus albus;* swamp eel), *Puntius* sp. (barbs), and *H. plecostomus*. In this account, which refers to *V. salvator macromaculatus*, predation on *H. plecostomus* was described but there was no mention of capture (Stanner, 2010). Grismer (2011) cited Boulenger (1903), who described *V. salvator* feeding on mudskippers probably belonging to either *Boleophthalmus* or *Periophthalumus* (Family Gobiidae), which are both found in Malaysia. *Pseudacocyrptes elongatus* is also considered a mudskipper; however, Boulenger's (1903) account took place on a mudflat, and this species typically stays submerged (Larson & Lim, 1997). Boulenger's (1903) account refers to what is presently known as *V. salvator macromaculatus.*

Published photographs also document fish predation by the *V. salvator* complex. For example, a photograph depicting a *V. salvator macromaculatus* eating a fish at the Sungei Buloh Wetland Reserve in Singapore appears on page 103 of *Biawak* 2(3). Cota (2011) included a photograph of a wild *V. salvator macromaculatus* that had captured a live tilapia at the Dusit Zoo, Bangkok, Thailand. A photograph appearing on page seven of *Biawak* 6(1) shows a *V. s. macromaculatus* consuming a freshwater eel (identified by the lead author of this article [MC] as *M. albus*.) at the Chinese Garden, Singapore.

There were only six primary sources of literature found documenting *V. salvator* catching fish: Boulenger (1903), Deraniyagala (1931), Gaulke (1991), De Lisle (2007), Karunarathna *et al.* (2008a, 2008b), and Wickramasinghe *et al.* (2010). Of the accounts reviewed which document fish predation, only four have documented the capture of fish in water (Deraniyagala, 1931; Gaulke, 1991; De Lisle, 2007, Karunarathna *et al.*, 2008). Gaulke (1991) reported fish being trapped in small pools of water, and Wickramasinghe *et al.* (2010)

reported fish being displaced from a shallow waterhole; neither reported fish being caught in open water.

**Methods and Materials**

The study of the monitor lizards in Thailand has been an ongoing research focus of the corresponding author (MC) since 2004. The observations described in this study occurred over the past nine years; however, the photographic evidence presented is from 2008, 2011 and 2013. Global positioning system (GPS) coordinates from 2008 were taken using a Garmin eTrex Legend and by a Garmin Dakota 20 (*Garmin Ltd, Olathe, Kansas, USA)* in September 2013. GPS coordinates in December 2013 were taken with an Apple iPhone 4S (*Apple Inc., Cupertino, California, USA*), being a chance encounter.

Although monitor lizards have been studied by the corresponding author (MC) throughout much of Thailand, the two populations studied most closely have been those at the Dusit Zoo, Dusit District, Bangkok and Lumpini Park, Lumpini District, Bangkok. Both populations are comprised of wild individuals that live within the metropolis of Bangkok. For more detailed information on the Dusit Zoo population, see Cota (2011).

**Results**

*Catching fish with inadvertent human assistance*

Visitors to Lumpini Park and the Dusit Zoo feed the local fish living in the lakes and waterways. Naturally occurring populations of *V. salvator macromaculatus* at both locations recognize that the fish can easily be caught when they congregate during feedings. At Lumpini Park, feeding of the fish occurs sporadically and in different locations; therefore, catching fish using this method is not observed often. At the Dusit Zoo, there are two locations where the fish are regularly fed. At one location, not far from the main entrance of the zoo (13° 46' 24'' N; 100° 30' 01'' E; 9 m ASL), wild fish are fed with bread. Here the fish are fed bread and in turn, the fish and occasionally the bread are eaten by *V. salvator macromaculatus*. In the other location, at the opposite end of the zoo, (13° 46' 14'' N; 100° 30' 58'' E; 9 m ASL), the fish are fed with fish food pellets. *Varanus salvator macromaculatus* do not appear to eat the fish food pellets, but have been observed catching fish here more often than in the other location where the fish are fed with bread.

*Catching fish without inadvertent human assistance*

On 24 September 2008 at 1628 h, the corresponding author (MC) observed a *V. salvator macromaculatus* pulling a live *Oreochromis aureus* (blue tilapia; Order Perciformes) out of the water at Dusit Zoo (13° 46' 14'' N; 100° 30' 59'' E; 9 m ASL). Although this location was only 31 m away from where fish are commonly fed, there were no people feeding fish in the area at the time. Figure 1 shows that the fish is still alive, with the position of the pectoral fin and the arch of the body indicating signs of struggling. This event was photographically documented by Cota (2011), but no specifics were given as to the proper identification of the fish and no details were given about the circumstances of when, where and how the fish was taken.

On 30 May 2011 at 1557 h, the corresponding author

Figure 1. A large *Varanus salvator macromaculatus* with a large live *Oreochromis aureus* (blue tilapia) that was captured in the water at the Dusit Zoo, Bangkok.

Figure 2. An adult *V. salvator macromaculatus* with a *Clarias gariepinus* (African catfish) at the Dusit Zoo, Bangkok. Circumstances of the capture were unknown.

observed a *V. salvator macromaculatus* with a *Clarias gariepinus* (African catfish; Order Suluriformes) at nearly the exact location at Dusit Zoo as the previous account on 24 September 2008 (Fig. 2). Similarly, there were no people feeding the fish in the area at the time, but the circumstances of the capture and whether or not it was a live capture are unknown.

On 8 September 2013 at 1058 h, the authors (MC and RS) observed a *V. salvator macromaculatus* pull a large live *C. gariepinus* out of the water at Lumpini Park (13° 43' 41'' N; 100° 32' 40'' E; 3 m ASL). In this case, the actual capture of the fish in the water was observed. From a closed mouth, the monitor grabbed the catfish with its jaws using a striking-lunging motion (like a snake), pushing its body forward concurrently with the straightening out of its neck. The catfish was then taken to the shore and pulled a meter away from the water (Fig. 3). Figure 4 shows the monitor lizard and the catfish shortly after movement stopped on land. At this point, the lizard assessed the area, then proceeded to devour the fish (Fig. 5), tearing away the outside flesh (Fig. 6). The internal organs were eaten as soon as the internal body cavity was opened (Fig. 7). After the internal organs were consumed, the lizard entered the posterior end of the occiput region through the inside of the body cavity. The remaining meat on the flanks was eaten last. Two other *V. salvator macromaculatus* approached, with one more persistent than the other, but were chased away (Fig. 8). The more persistent individual did manage to grab a bite of the fish while the original animal's mouth was full (Fig. 9). The original lizard had nearly consumed the entire catfish before leaving its prey to other monitors and crows that were lurking nearby (Fig. 10).

At 1510 h on 8 December 2013, the corresponding

Figure 3. A small adult male *V. salvator macromaculatus* pulling a live *C. gariepinus* onto the land away from the water. Photographed by **Ralf Sommerlad**.

Figure 4. A small adult male *V. salvator macromaculatus* shortly after pulling a live *C. gariepinus* from the water onto the shore of the small lake. Photographed by **Michael Cota**.

Figure 5. *Varanus salvator macromaculatus* assesses the area and examines his prey. Photographed by **Michael Cota**.

Figure 6. *Varanus salvator macromaculatus* tearing into the flesh of *C. gariepinus*. Photographed by **Michael Cota**.

Figure 7. *Varanus salvator macromaculatus* consuming the internal organs of *C. gariepinus.* Photographed by **Michael Cota**.

Figure 8. Chasing an equal-sized rival away from its prey. Photographed by **Michael Cota**.

Figure 9. The rival returns and grabs a bite while the hunter has its mouth full. Notice that the lateral fold that was distinct earlier has now disappeared posteriorly, due to a full abdomen. Photographed by **Michael Cota**.

Figure 10. Nearing the end of the meal, the lateral fold is no longer distinct as the body cavity of the *V. salvator macromaculatus* is nearly filled with the *C. gariepinus.* A *Corvus macrorynchos* (large-billed crow) waits for the monitor to leave its prey, as does a conspecfic behind it. Photographed by **Michael Cota**.

author (MC) observed a *V. salvator macromaculatus* pulling out a *M. albus* from the edge of a waterway at the Ayutthaya Historical Park, Mueang District, Ayutthaya Province (12° 21' 09'' N; 100° 33' 27'' E; 8 m ASL). The monitor was first seen foraging along the edge of the waterway for prey, where it was also observed catching prey items which could not be properly identified; these may have been small mollusks (snails) based on the behavior used in swallowing the items. The *M. albus* was also caught along the edge of the waterway, where it was seized by the monitor using a striking motion with the head being quickly thrusted forward while straightening out the neck. The prey was quickly moved onto level ground ca. 60 cm up the bank (Fig. 11). By the time the monitor pulled the eel up to level ground, the eel had managed to wrap its body around the neck of the monitor; similar to how a snake would respond when captured by a monitor (Fig. 12). The eel was thrashed by quick downward motions at a near 45° angle, beating the eel's body against the ground. The head of the eel was manipulated towards the throat of the monitor lizard (Fig. 13) by re-biting the prey in quick succession ever closer to the head until it was pointing towards the throat, and was consumed within approximately two minutes (Fig. 14). After consuming the prey, the monitor returned to the edge of the waterway, where it briefly foraged for about 30 m before crawling up the bank to level ground to bask for an extended period of

Figure 11. *Varanus salvator macromaculatus* taking a freshly caught *Monopterus albus* (swamp eel) up the bank of a waterway up to level ground. Photographed by **Michael Cota**.

Figure 12. After the *V. salvator macromaculatus* has taken the *M. albus* to level ground, it manages to wrap its body around the monitor's neck, similar to what a snake would do. Photographed by **Michael Cota**.

Figure 13. *Varanus salvator macromaculatus* manipulates the head of the *M. albus* in order to consume it head first. Photographed by **Michael Cota**.

Figure 14. After the head of the *M. albus* is manipulated towards the throat of the *V. salvator macromaculatus*, the prey is consumed quickly. Photographed by **Michael Cota**.

Figure 15. *Varanus salvator macromaculatus* basking a few minutes after consumption of a moderate-sized *M. albus* meal. Photographed by **Michael Cota**.

time (Fig. 15).

In all observations made during this study where *V. salvator macromaculatus* had captured large aquatic prey (prey that could not be quickly swallowed whole), prey items were taken out of the water for consumption. Prey is not merely brought to the shore or edge of the water; it is usually carried some distance away from the water. This action could help prevent prey from escaping back into the water.

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# HISTORICAL FACSIMILES

## The First Varanid Biologist

Few dedicated investigations into the biology of varanid lizards occurred prior to the 20th century. Most published accounts on varanid biology up until that point had originated from casual field observations made mostly by amateur naturalists, or from captive specimens maintained in European zoos and private collections. Unheard of at the time, the first systematic investigations into the biology of varanid lizards were carried out during the late 19th century in central South Africa by Alfred Brown.

Brown, an English expatriate that emigrated to Aliwal North, South Africa in 1859, is probably best known among the scientific community for his contributions to the then-emerging field of paleontology during the latter half of the 19th century. However, Brown also carried out extensive studies on captive varanid lizards which remain largely unmatched today and rank among some of the most detailed investigations carried out on *V. albigularis* to date. As summarized in great detail by Branch (1991), Brown studied various aspects of the biology of *V. albigularis* over a period of more than three decades, including sex ratios, size, body proportions, hemipenal morphology, fat bodies, coloration, diet, mortality, longevity, reproduction, gestation, oviposition, clutch size, incubation period, growth, behavior, social interactions, thermoregulation, predation, parasites, seasonal activity, and exploitation. Sadly, this research went largely unnoticed by science for much of the 20th century, until Branch (1991) transcribed and interpreted the data and results from Brown's private journals. Additional details about Brown and his life and scientific contributions are given by Drennan (1947).

Although Brown never published the bulk of his varanid research (Branch, 1991), he did author some popular articles on *V. albigularis* (Brown, 1871a,b). One of these articles, reprinted below, provides a fascinating look into some of the biological investigations and behavioral experiments that Brown carried out on captive specimens of *V. albigularis* under his care, as well as anecdotes and local folklore pertaining to the species.

-RWM

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## The Monitor Albigularis: A Monograph


ALFRED BROWN

*Aliwal North*


The following notes on the habits and instincts of the terrestrial Monitors of South Africa are mainly based on experiments and observations made on a specimen which existed in captivity during a portion of 1868-1869. Further information of its habits, and of the superstitions relating to it have been obtained from sources both

written and oral. Nearly two years have elapsed since these observations were recorded, and from that time to the present no opportunity has been lost to obtain fuller information about this reptile; but the most strenuous efforts have hitherto failed to procure another live specimen. The Monitor to which these notes owe their existence measured three feet in length, and was caught while basking on a low stony ridge some distance from the Orange River. My occasional rambling among the remains of extinct reptiles, but more especially the discovery of Dinosaurians in the „Stormberg beds“, made me anxious to obtain speeimens of the Monitor, which, though rare in this locality, was the largest reptile within my reach. It was not until three weeks aftcr its capture that my attention was specially drawn to a close examination of the Monitor‘s habits. Moreover, my interest in this reptile was further inercased by the Statements of eminent anatomists that the skcleton generally, and the cranium particularly, indicate the natural passage from the order of lizards to that of serpents, and that we also find in the great extinct Saurians, such as *Megalosaurus*, *Mososaurus*, and the South African Dinosaurs, the closest resemblance to the comparatively diminutive Varanians, which are now the inhabitants of our globe. Should the inferences and deductions in this paper be approximately correct in relation to this Singular terrestrial species, which, in common with the aquatic Varans, come nearest to the great extinct Saurians of old, and should the habits ascribed to this Varan, as well as to the other species not here noticed, bear any relation to those of the great extinct Dinosaurians, now swept away from the face of the earth, then we should have in those annihilated giants of primeval times no bad representative of our wildest legends. Let me first give a detailed description of the creature.

*Colour* — On the neck and back, alternate dark-brown and yellow patches, blotches, or continuous stripes; a deep-brown stripe, extending from the corner of both eyes, along the side of the neck, and coalescing behind the shoulders; sides and belly of the animal yellow, with brown spots, and sometimes stripes intermixed; tail marked with alternate brown and yellow bands above, and by a somewhat lighter yellow beneath. The brown bands, patches, or blotches are frequently spotted with yellow, and the latter colour is frequently marked with. brown spots. The toes are variegated in like manner, but have the nails dark-horn coloured.

*Form* — The limbs are thick and strong; the neck, body, and base of tail robust, but rather flattened; the tail about twice the length of the trunk, and slightly compressed at the sides nearly throughout its entire length; head rather small, short, and triangular, broad behind, and tapering towards the nose; tongue similar to serpents, but twice the length of the head; teeth somewhat cylindrical and strong; nostrils oblique, linear, and situated near the eyes; toes long and unequal, especially on the hind feet. They are five in number, and are entirely distinct and separated from their base.

*Scales*.— On the surface of the head they are flat, — rather small and circular; they are oval on the chin,

*Varanus albigularis*. Kruger NP, South Africa. Photograph by **Nick Dean**.

*Varanus albigularis*. Philippolis, Free State, South Africa. Photograph by **Victor J.T. Loehr**.

throat, sides of the neck, on the lips, and towards the base of the tail. The scales on the neck are more raised and of larger size than on any other part of the reptile. The scales on the back and sides differ from those on the neck in being of smaller size and less convex. The scales are disposed in transverse rows or bands on the neck, ribs, and belly of the reptile, but on the tail they are arranged in regular rings.

This species of Monitor dwells in the chinks and cavities of rocky precipices and low stony ridges and hills, and also in holes in the ground when no rocks are near. In the summer season they resort to cultivated lands, to muddy pools, and to running streams of water, but are not able to remain beneath the surface for any length of time. The captive Monitor bathed in water during the hot weather, but always kept its nostrils above the surface. I never saw it eat its food in the water, which is the reverse of the habits of a marsh tortoise in my possession, which never eats the least food except in that element; but when hungry, if food is given it on the land, it will sometimes seize it, and make for water before attempting to swallow. Should no water be near, the food is dropped, and no further attempts will cause the tortoise to seize it again. Put the tortoise near shallow water, and it will plunge in. Place the food near it, and it will seize it voraciously, drag it under water, and swallow it. At the Diamond-fields, a Monitor entered a tent, effected its escape, ran some distance, and dashed into the river direct for the opposite banks, where, meeting, with resistance, it returned and was killed. The reptile showed not the slightest disposition to remain in the water, for had it done so, it could easily have escaped. They have been found more than twenty miles distant from any stream, and have been seen running about the sandy tracts of land beyond the Transvaal. In those parts, when molested, they often effect their escape into holes in the ground. These facts are borne out by the statements of many persons. In severe droughts, these reptiles resort to rivers for the purpose of bathing; but I have never seen them basking on the banks of rivers. Several persons who saw my specimen when living, including gentlemen capable of judging, assured me that there was considerable difference between it and those which abounded near rivers. It is known as the Mountain or Berg Iguana of the Colonists, the Phoolo of the Tambookies, and the Qibe or Kabai of the Fingoes and some other tribes. The food of the Monitor, as founded on observation, and also on the examination of the stomachs of these reptiles, consists of small quadrupeds and birds, also mice, rats, eggs, lizards, and tortoises. In captivity, the Monitor drank milk with greater avidity than water. In six months, exclusive of other food, he ate forty-seven hen and ducks' eggs, twenty-two eggs of birds and tortoises, nine mice, two rats, one hundred and ninety locusts, thirty-four birds, chiefly sparrows, and three lizards.

I next notice the tongue as an organ of exploration, touch, and taste, and of attack in certain cases. It is long, rather slender, filiform, and terminated by two points, which can be widely divaricated, as in the serpents. The tongue of a Monitor four feet long measures 9 ½ inches in length, and the length of each fork is 1 ¾ inches. It is marked with deep-blue and straw-coloured bands. The Monitor can use this organ in any direction, and

can almost double it upon itself. Aided by the rapid protrusion and retraction of this singular organ, it carefully explores every nook, corner, and crevice of its cage. The tongue appears to be able to stupefy, to render helpless, and probably to deprive of consciousness small birds, locusts, and soft-bodied insects. Birds and certain insects appear to be the only creatures that are injured by it; for in several experiments, the hare, hyrax, rats, and mice were put within its reach, and were several distinct times observed to be repeatedly touched without harm. A young hyrax seemed to enjoy the titillation produced by this cause, and was so little awed by the Monitor›s presence that it would snatch food from its jaws. The tongue, when in full play, is frightful in the extreme; its puffing, like several adders in chorus, is terrible, and the fiery and angry expression of the eye is so formidable as to cause it to be dreaded by many of the aborigines. Its horrid expression when aroused has such a snake-like aspect that it fills its enemies with dread, and is sufficient to deter most dogs from attacking it. Has not the Monitor›s tongue power to exude formic acid, which is one of the principal constituents of chloroform; and may it not have an anaesthetic effect upon its victim, especially as this reptile touches the most unprotected parts of its prey, such as the eyes and under the wings, where the nerves are very sensitive? Has not the tongue of serpents, which is also long, slender, and bifurcated, something to do in producing sudden helplessness in certain animals? May not the serpent in many instances dart out its long slender tongue with inconceivable swiftness in like manner as the Monitor, and touch its victim when near at hand, unperceived by the spectator, and thus cause the animal to tremble all over, to feel incapable of escaping, or to rush blindly into its enemy›s power; and may not the flashing eye and rapid evolutions of the forked tongue render some animals powerless, even when some distance off?

*Varanus albigularis*. Kruger NP, South Africa. Photograph by **Bernard Dupont**.

When the Monitor took its prey, it always swallowed it head foremost. If the victim was rather more than two-thirds the size of a small sparrow-hawk, the reptile experienced considerable difficulty in the process. The sides of the mouth were dilated as much as possible, and the jaws were pressed against the sides and floor of the cage as an aid in forcing the victim down its throat. When the prey was firmly seized, it appeared to lose all consciousness, and was crushed in the reptile›s jaws without showing any movement. One day it caught a rat, which it endeavoured to swallow head foremost, but could not do so except by great efforts. Some time after the body of the rat was down the reptile›s throat, the hind legs and tail were hanging out of its mouth; the act of swallowing lasted about ten minutes. When the rat was caught it squeaked, but the instant the reptile had fair hold of it, and gave it a shaking, there were no more signs of feeling.

After taking a meal, the Monitor›s tongue was always brought into unusual activity. The Monitor would dart out its tongue, and alternately dilate and contract its bifid extremities, work the tongue around its jaws, and occasionally, to do it more effectually, would nearly double the tongue upon itself, and lick its jaws with the points only. It would then suddenly withdraw its tongue, nearly close its mouth, and cause the points of the tongue, with alternate protrusions and contractions, to vibrate between the lips. The tongue seems to be the seat of the most pleasurable sensations, for at the close of every meal this organ was in ceaseless motion for about five minutes. Always in drinking, whether it was milk or water, the bifid tips of the tongue only came in contact with the fluid. The points of the tongue were rapidly inserted into the fluid and withdrawn, —an

*Varanus albigularis*. Photographed by **Peter du Preez**.

operation which was repeated several times. This, to my observation, was the only act of drinking the reptile practised.

The mere presence of the Monitor has no such effect as fascinating or striking the imprisoned animal with dread; for at times, when for some reason — perhaps over-eagerness to catch its prey — it does not use its tongue, it will chase its victim with gaping mouth, and sometimes almost seize it, yet the prey escapes. At other times I have seen the Monitor, with stealthy step, slowly attempt to capture a sparrow, and, notwithstanding, the bird would fly or hop some distance off. It is only when the reptile uses its tongue, which always gives it a fierce and imposing aspect, that it can seize its prey with ease. I have seen birds from the moment of being put into the cage to be quite lively and fly about, or perch, as the case may be; and mice, under similar circumstances, search for food regardless of the reptile›s presence. Again, birds have perched on the Monitor›s back, or on its head, or hopped over its body for more than an hour, without any fear or injury. Mice will crawl on it, smell it all over, poke their noses against the reptile›s jaws, and remain unharmed. During the whole proceedings, the only notice the Monitor appears to take is to shut its eyes when the animals come too near him, but at such times, when these strange liberties are taken with the reptile, its formidable nature is in abeyance; there is no puffing, no flashing eye, no serpent-like tongue darting to and from; but the reptile, with appetite appeased, is indolent and unconcerned. Should it under these circumstances go after its prey, it does so in a sluggish and purposeless manner; but when aroused, which it shows by its puffing, etc., those animals no longer treat it with contempt, but fly from its presence. In cold weather, two hyraxes and the Monitor, or the reptile and a hare, frequently slept in the same retreat. The reptile would curl itself up, and these animals would sleep on its body for hours together. Instances of animals in a state of nature occupying the same burrow as the rattlesnake are not uncommon.

I introduced a sparrow-hawk (*Falco Capensis*, and *Roode Valk* of colonists) into the cage. It hopped a short distance forward, when its quick eye noticing the Monitor, it suddenly stood still, but did not manifest any signs of uneasiness. The reptile rose up actively, began slightly blowing or puffing, reached over the artificial ledge of rock on which it was basking in the sun, and rapidly darting out its singular tongue, it touched its victim on the head. The hawk instantaneously trembled, and appeared totally incapable of making the least resistance, or of attempting to escape, but remained rooted to the spot as if under some powerful mesmeric influence. This species of hawk generally, when attacked by an enemy more powerful than itself, utters shrill notes of defiance, puts itself into an attitude of defence, and resists to the last; but now, in the presence of this reptile, it uttered no cry, nor showed the slightest attempt at resistance, but passively submitted to its fate. The Monitor leisurely touched its victim several times about the neck, and once on the left eye. It then descended from the ledge, again touched with its tongue the unresisting bird, raised up the victim's wing with its head, and touched the unprotected skin with its tongue. After repeatedly touching the doomed bird, it deliberately walked round it, without again using its tongue; and seeming satisfied that its victim was safe, the reptile deliberately walked from the spot, but not before it had opened its jaws and apparently endeavoured to find out whether the prey was too large to swallow; for, incredible as it may appear, the bird was so lightly taken in the Monitor's jaws that it was neither moved from the spot nor raised from the ground. When it was decided to place the hawk within reach of the Monitor, not the least idea was entertained of such a singular scene as I now witnessed, — the prominent impression being that the bird would be quickly killed and swallowed. After waiting a short time, and satisfying myself that the Monitor showed no inclination to devour its victim, I at once took the poor bird out of the cage, with the intent of of trying to recover it. Immediately on rescuing the bird, I found that it was perfectly helpless and incapable of the least resistance; its claws were spasmodically clenched together, the eyes were dull and heavy, and

the muscular system was in such a state of rigidity that the paralyzed victim remained in any position in which it was placed, and so helpless that it could easily and unresistingly have been crushed to death in the hand. The hawk was in the cage about fifteen minutes, and remained until 1:45 p.m. (thirty minutes) incapable of showing the least resistance or of exhibiting any signs of renewed muscular action. Two p.m. (fifteen minutes later), it appeared to be gradually recovering, but showed no resistance when ten in the hand. Four p.m., more lively, excessively tame, ate some meat, and caught and killed a mouse which was placed near it.

The effect of the Monitor's tongue on the eye of the hawk was most permanent in its injurious effects. The next morning after the eye had been touched by the reptile's tongue, I observed that the eye-lids of the left eye were nearly closed and slightly swollen. On the following day they were more swollen, and a slight tumour became visible, which increased and became much larger on the third day. At the end of a week from its commencement, the tumour had increased to the size of a pea, and was very white. The eye was closed up for about six weeks, during which time the bird was lively and ate heartily. The tumour afterwards so decreased in size that the hawk could use its eye, which appeared not the least injured. From this time, until the day of its death, eight months after the injury, the tumour never disappeared, but alternately increased and decreased, sometimes becoming very small, and again increasing to its largest development, so that the bird could scarcely see out of it.

The hawk had been caught about two hours before being put into the cage, and the reptile also had only been captured a short time previously; consequently, their instincts were unimpaired and their habits had not yielded to the influence of restraint. The hawk was very fierce and intractable, using its claws and beak in its defence; but after the above singular encounter with the Monitor, it became excessively tame for nearly three weeks. At the end of this period it suddenly manifested an unusually daring, fierce, and intractable spirit, and not only would peck and strike with its claws at any person who came near, but would fight lustily with a large horned owl. It sustained this fierce and violent disposition until its death. This intractable spirit is most unusual in this species of hawk. I afterwards had several of these hawks, and found that although they are pert, active, and saucy birds, in general, they in a short time became very tame and almost regardless of the presence of human beings. Three escaped and flew away, two were readily caught, and the third one flew a considerable distance off and appeared to be gone altogether, but in half an hour it also returned, began feeding near the cage, and allowed itself to be easily taken.

Several experiments were made with this hawk, and, strange to say, the second time it was put into the cage it did not show the least fear at the Monitor's presence. Soon it did not pay the least regard to the reptile, except when the Monitor tried to catch it. The hawk was then quick and active, but when hardly pressed it invariably jumped on the reptile's back. The hawk well knows its enemy, but does not manifest so much fear of the Monitor as it exhibits in the presence of man. As long as the reptile leaves the bird alone, which is nearly all day, it will eat, flap its wings, hop about or perch, and appear perfectly comfortable under the circumstances. Several days later the Monitor showed some desire to catch the hawk, and deliberately chased the wary bird which, with very little excitement, kept out of the reptile's way. The cage admitting of concealment, the Monitor showed cunning in trying to capture the hawk, made sudden dashes at the bird and darted out its tongue without effect, as the hawk, though taken by surprise, was too nimble for it. The Monitor used its tongue freely in its desperate attempts to catch the bird, and at last touched the hawk on the legs, but without any injurious effect.

I next introduced a large common horned owl (*Strix africana*) into the cage which was temporarily slightly darkened, — first, to see if the Owl would manifest any fear or become motionless on seeing the reptile, and secondly, to observe whether the Monitor would touch the bird with its tongue, and to carefully watch the effect produced. When the owl was put into the cage, the Monitor was lying stretched at full length on the artificial ledge of rock. The instant the owl was introduced it turned round and faced the reptile, which brought its head a few inches below the line of the Monitor. The owl stood in an attitude of defence and carefully watched the movements of its enemy. The reptile prepared for the attack, raised its head up, turned round towards the bird, and quickly darted out its tongue, but as rapidly withdrew it, as the owl snapped at it, and did not use it again during the strife. Finding it had a formidable antagonist in the bird, its sluggish nature was aroused, its old spirit began to show itself, and with flashing eye and loud puffing it rushed off the ledge towards the bird. On reaching the ground it renewed the attack in a different manner to its usual habits of capturing smaller prey. Still puffing, it struck at the bird with its tail very forcibly, but harmlessly, as the owl flew on the ledge

and loudly hissed at the reptile. The reptile struck at the owl several times, but always used its tail in its attempts to destroy the bird. These repeated attacks caused the owl to become frightened, but not in the least affected in its instincts and desire of life. The owl temporarily succeeding in getting beyond the reach of the reptile, began to consider, as it were, what was to be done — one moment it was looking at the top of the cage and the next carefully watching the Monitor. This continued several minutes, — the owl trying to find means of escape, and yet watching the movements of its enemy, while the reptile was vainly striking at the bird with its tail. Having allowed a considerable time to elapse, and seeing that the reptile only used its tail in the repeated attacks, and did not use any other means of offence, although thoroughly aroused and angry, the owl was taken out.

Several other experiments were made at suitable intervals, and in every case the powerful muscular tail was dashed about like a club at the object. The dog which aided in its capture was placed close to the wire-netting, and urged to bark, when the reptile was instantly aroused, and lashed the sides of the cage with its tail furiously and continuously until the dog was taken off the cage. A large baboon was partially forced into the cage, when on seeing the reptile, it was struck with terror, began to struggle violently, and to bite the person holding it. So permanent was the effect of the fright that the baboon would start and jump at the sudden fall of anything near it. A friend mustered courage to partially enter the cage, when the Monitor struck out lustily with its tail, so as to cause him to leave the reptile in peace. The large hare and the hyraxes when first put into the cage were struck at by the reptile. The tongue was not used; neither was there any attempt to bite either of these animals. The tail is a very powerful instrument, both offensively and defensively. It is sufficiently powerful to break the bones of an enemy of considerable size; probably much larger than a spaniel.

In my eagerness to capture the Monitor — the subject or this paper — I thought of nothing but the object in view, and was too excited to notice anything except that a running fight took place between it and the dog, and that it opened its jaws and nearly seized the resolute animal, which I prevented with difficulty; but having cooled down, I stooped and looked under the ledge of rock under which the reptile ran, which brought me within four feet of it, and I saw that it was crouched flat on the ground and looking very vicious, and also heard a noise, which at first seemed to be wind escaping through some crevice of the rock, but which proved to be the puffing or blowing of the animal. I then observed that the reptile was recovering its strength, and that its vicious disposition was showing itself to an equal degree. Wishing to obtain the creature uninjured, it was treated as mildly as possible, and was watched some time until the opportune appearance of two natives enabled me to fix a reim to one of its hind legs, when it was drawn out, resisting violently, and holding tenaciously to the projections of the rock. Eventually it was disengaged and placed in security, but not before I had seen some of its powers of resistance, especially its strength of jaw, which seized and held a stick so firmly for about eight minutes that by fair force I could not withdraw it, but preferred waiting the reptile's pleasure.

"Often", writes a late French missionary, "they were attacked by dogs, keeping them at bay. When this happened the reptile began to puff and hiss in an awful way, darting out its tongue and copying the Snake. This ugly expression was generally sufficient to frighten away the dogs. If, notwithstanding, the dogs continued to approach, the reptile used its tail, striking with such violence as to break the legs of the antagonist which came within its reach. Sometimes these means of defence failed altogether when the dogs were many, and they succeeded in worrying the poor animal. In that case, it had recourse to a last expedient — namely, to counterfeit death, which it did so well that after being bitten and worried by the dogs, any person would say, 'the reptile is dead'; but if an hour after you looked for it, it was gone". "When any irregularities", says Dr. Smith in his "Zoology of South Africa", "exist on the surface of the rocks or stones, with which it may be in contact, it clasps them so firmly with its toes, that it becomes a task of no ordinary difficulty to dislodge it, even though it can be easily reached. Under such circumstances the strength of no one man is able to withdraw a full-grown individual. And I have seen", continues Dr. Smith, "two persons required to pull a specimen out of a position it had attained, even with the assistance of a rope fixed in front of the hinder legs. The moment it was dislodged it flew with fury at its enemies, who by flight only saved themselves from being bitten. After it was killed, it was discovered that the points of all the nails had been broken previously, or at the moment it lost its hold".

Many fanners have informed me that these reptiles kill young lambs by inserting their long tongues up the lambs' nostrils, and from thence extracting their brains. Some farmers informed me that their herds had caught the reptiles in the very fact. Another farmer styled them villainous rascals, and said that they caused him considerable trouble, as they often killed his lambs, bit

the head open, and ate the brains through the openings in the crushed skull. My informant knew them well, pointed out the mountain which they generally dwelt, but could give no information of their combative powers, as whenever he had the opportunity of tracing them out he always shot them. He further ridiculed the idea of taking one alive. A gentleman possessing some knowledge of these reptiles told me that although he did not believe in the Monitor's fondness for sheep's brains, yet he could assure me that they will attack lambs, and that he has seen the ewes come home dreadfully bitten on the head and front feet in their courageous attempts to defend their young, which they generally succeeded in carrying off in safety. They are also accused of visiting homesteads for the purpose of obtaining eggs.

The Fingoes, the Gaikas, and some other native tribes assert that the bite of the Monitor is deadly, and have the following superstition—that "when a person is bitten by one of the reptiles he must make for the nearest water without delay, for should the reptile arrive there first he will surely die". The Fingoes of the Wittebergen look upon the capturing of a Monitor as a great prize, and will not readily sell it. The skin is used as a medicine and a charm by their native doctors, and occasionally a native is seen with a narrow strip around one of his wrists.

"The Bechuanas", writes a late French missionary of repute, "have the superstitious notion that this reptile has a great influence on the rain; consequently, they are afraid of doing it any harm, for fear of driving away the clouds. This notion arose from the fact that this reptile likes to bathe in muddy pools during the summer heat, and that since it feels the need of water and delights in it, it must have some influence on the rain, and to kill it might spoil the rain. These people also accused the reptile of being fond of milk, and of visiting the cattle enclosures at night in order to suck the milch cows. This they said it sometimes succeeds in accomplishing when the cows lie down to rest. Once a native dragged one with a reim, accused of having eaten pumpkins in his garden, and begged of me to kill it with my gun. It is not improbable that the native was afraid that his garden might be destroyed by a drought or by a hail-storm, if he should himself kill the reptile". "But", continues the worthy missionary, "an accusation more serious than the eating of vegetables was once brought against one. The Monitor had penetrated during the night into one of the native fences. This happened in the hot season, when people generally sleep out under a verandah. A native woman nursing a babe was thus sleeping with the rest of the family, when one of these reptiles, attracted by the smell of milk, endeavoured to obtain some from her breast. The father, horror-stricken, came to me next morning; he was very excited, and considered what had happened to his wife the greatest curse imaginable, and was anxious to know how she could be purified. I tried to persuade him that no harm would follow, but advised him to have the reptile killed, to prevent the repetition of such audacity".

The nature of the tongue of the Monitor is specially worthy of experiment and research, for the peculiarities of the organ are notably characteristic of serpents. Further, the study of this reptile, which also resembles snakes in its habits of attack and defence, in the peculiarly raised position of its head at such times, in the angry blowing, the dilated jaws, the expanded neck when irritated, and its tenacity of life, is, from the comparative ease of observation, well worthy of research, — for the habits of the varans may well illustrate similar characters in the serpents.

The constant movements of the antennae in insects under certain conditions, and the tactile organs about the mouth of some fishes, appear to be somewhat analogous to the rapid evolutions of the tongue of these reptiles. Both the Monitor and the snake make themselves far more formidable to the eye by the singular activity of this organ than they otherwise would be. In no other animals is the tongue brought into special activity when they are attacking an enemy or defending themselves. The captive Monitor did nothing of importance without bringing its tongue into requisition. Introduce a new animal into the cage, or make fresh alterations therein, the reptile, though aware of some change, was not satisfied until the object was examined or the alteration underwent severe scrutiny by the aid of its tongue. Placed in fresh compartments every nook and corner was submitted to the tactile process of examination. Food was carefully touched all over before eating, and after meals indescribable vagaries of this organ were exhibited.

In the case of attack or defence, the tongue may be used for the express purpose of creating terror, — the examination of the food may be of a tactile character to find out the nature and size of its prey, especially as the Monitor swallows its food whole, merely crushing it as it passes through its jaws. But what sensations are conveyed to the animal when touching wood and stone, etc., unless it enables the reptile to define or ascertain the limits of its own individuality apart from extraneous objects, — and why does it appear to create more or less helplessness when small birds and certain insects are the object of its notice? Moreover, the tongue appears

to be only injurious when small birds and insects are the objects of its notice. Birds larger than a sparrow-hawk of nine inches in height, and even small animals, such as rats and mice, appear not to be affected by the tongue, but are destroyed by blows given by the reptile's tail, which is very muscular, and consequently very powerful.

Finally, many interesting points, not noticed above, will repay the observer of the habits of this Monitor, such as the shedding of its skin, its climbing propensities, its serpentine movements in running, its remarkable power of compressing its body when endeavouring to escape through narrow crevices in rocks, and also the quietness with which it becomes accustomed to the hand that feeds it.

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# ILLUSTRATIONS

## CAREL BREST VAN KEMPEN

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With over 20 years as an artist, naturalist and author, Carel Brest van Kempen's artistic mission has always been to deepen awareness of the natural world and how it functions. His family hails from Indonesia, the land of the Biawak. His work has been exhibited worldwide in such venues as The Smithsonian, The British Museum and The National Museum of Taiwan. He was named a "Most Honored Artists of Utah" (2002) and a "Master Signature Member" of the Society of Animal Artists (2008). He has illustrated over a dozen books, including *Dinosaurs of Utah* (1998), *Biology of the Gila Monsters and Beaded Lizards* (2005), *Biology of the Boas and Pythons* (2007), *Urban Herpetology* (2008), and *Conservation of Mesoamerican Amphibians and Reptiles* (2010) and authored the popular coffee-table book, *Rigor Vitae: Life Unyielding* (2006). In addition to painting, he actively writes and blogs about natural history and conservation themes. It is important to Brest van Kempen that his overall body of work reflects the great diversity of nature, but he still finds himself favoring certain taxa, most notably lizards. He says, "There isn't another vertebrate order or suborder that matches lizards for diversity of lifestyle and morphology. Among the lizards, the monitors are probably my favorite family to portray, because of their intelligence, intensity and wonderful movements."

"Salvadori's Monitor & Papuan Naked-tailed Rat". 1993. Acrylic on illustration board, 20" x 30".

“Gripping Tail - White-throated Monitor & Yellow Baboon”. 1994. Acrylic on illustration board, 30” x 20”.

"Green Tree Monitor & Lesser Bird of Paradise". 2012. Acrylic on board, 9" x 14".

"A Kerangas Forest Floor - Hatchling Dumeril's Monitor". 2012. Acrylic on illustration board, 30" x 20".

Captive-bred *Varanus albigularis* hatching. Photographed by **Király János**.