

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

MICHAEL COTA^{1,2*} & RALF SOMMERLAD³

¹*Faculty of Science and Technology
Suan Sunandha Rajabhat University
1 U-thong Road, Dusit District,
Bangkok 10300 Thailand
Email: Michael.ro@ssru.ac.th*

²*Natural History Museum, National Science Museum, Thailand,
Technopolis, Khlong 5, Khlong Luang,
Pathum Thani 12120 Thailand
Email: Herpetologe@gmail.com
corresponding author

³*Roedelheimer Landstraße 42
D-60487 Frankfurt/Main
Germany
Email: crocodilians@web.de*

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 Traholt'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 *Periophthalmus* (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 Scleropterygii) 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 macrorhynchos* (large-billed crow) waits for the monitor to leave its prey, as does a conspecific 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 thrust 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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