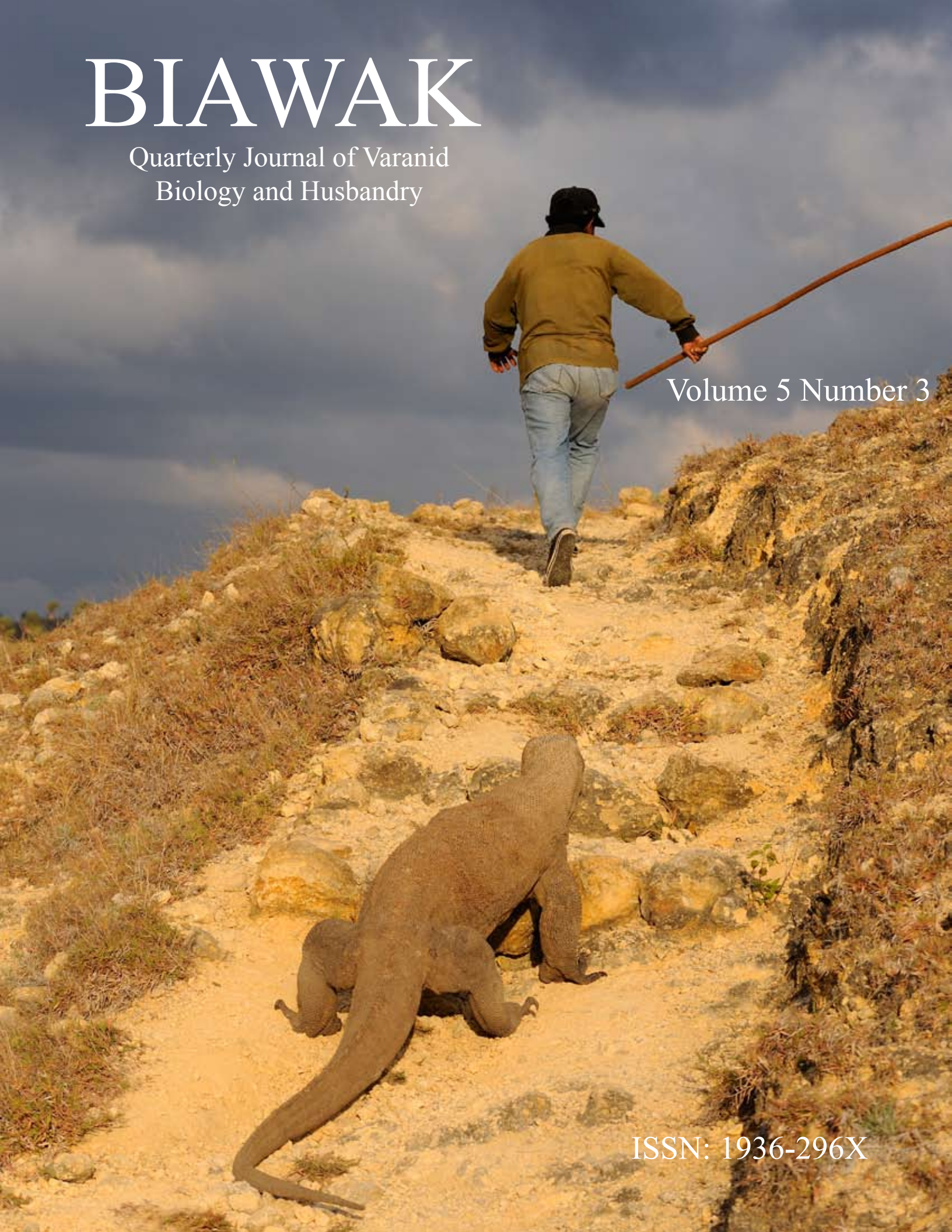
BIAWAK

Quarterly Journal of Varanid Biology and Husbandry



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On the Cover: *Varanus komodoensis*

The *Varanus komodoensis* depicted on the cover and inset of this issue was photographed by **Jeremy Holden** on Rinca Island in late July 2011 during the making of a film for National Geographic Channel on *Homo floresiensis* and Komodo dragons. Unlike the mainland Flores population, the dragons on Rinca, although still dangerous on occasion, are now accepting of humans and can be approached to within meters.

The photograph on the cover and to the left shows one of the Komodo National Park rangers luring a dragon with a dead fish. A number of dragons visit the park head quarters, occasionally menacing kitchen staff and even attacking rangers - a notorious incident in 2009 saw a dragon climb in to the park ticket booth and bite a ranger on the arm as he struggled to escape through the window. These animals are often co-opted into appearing in TV documentaries, as was the case with the dragon in these photographs.

Jeremy Holden is a 45-year-old photographer, naturalist and explorer. For the past 25 years he has been traveling the world in search of wild places and mysterious creatures. In 1994 he began working with the British conservation organization Fauna & Flora International to help document and preserve some of Southeast Asia's most threatened ecosystems. During his field research he developed camera trapping techniques which he has used all over Asia to document rare and cryptic animals, especially those in tropical rainforests. Holden has a degree in photography from Nottingham Trent University. When not taking photographs he writes about his discoveries. His most recent publication is the first field guide to the amphibians of Cambodia.

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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*, a quarterly journal of varanid biology and husbandry, and is available online through the IVIG website.

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Varanus mertensi. Katherine, Northern Territory. Photograph by **Bruce Doran**.

NEWS NOTES

Virginia Komodo Dragon To Be Sent to Toronto Zoo

The Virginia Aquarium & Marine Science Center in Virginia Beach has announced that one of their Komodo dragons (*Varanus komodoensis*) will be sent to Canada's Toronto Zoo to help expand that facility's breeding program for the species. Kiki, a six year-old female, was moved to her new location in June. Her and her mate will eventually be placed on public display.

Source: The Virginian Pilot, 16 June 2011

Conflicting Reports on Florida's Nile Monitor Population

Sightings of the Nile monitor (*Varanus niloticus*) in West Palm Beach, Florida appear to be on the rise this year; a statement which contradicts earlier hopes of wildlife officials that the previous winter's severe temperatures had reduced the alien species' population in the state. It is still too early to say whether the lizard's numbers really are increasing or merely the frequency of sightings being reported. Wildlife officials are beginning surveying and trapping efforts in Broward and Palm Beach counties to attain more information. However, trapping efforts in the Cape Coral area appear to show a decrease in the species' presence. In previous years, as many as seventy specimens had been captured per week; a figure that is now down to around half that. It is estimated that approximately one thousand individuals exist in the Cape Coral region with the population concentrated in the southwest.

Sources: West Palm Beach News, 29 June 2011; WINK News, 2 August 2011

Komodo Dragons Exhibited at Oklahoma Zoo

Two Komodo dragons (*Varanus komodoensis*), female siblings originally from the Los Angeles Zoo, were given to the Oklahoma City Zoo earlier this year and put on public display this summer. The yearlings will eventually join an adult male already at the facility when the zoo's new Asia exhibit opens in 2013.

Source: NewsOK, 2 August 2011

Parthenogenetic Komodo Dragons Hatch at Prague Zoo

Four eggs laid by Aranka, the Prague Zoo's Komodo dragon (*Varanus komodoensis*), have hatched. This event represents the fifth instance of egg-laying for Aranka making her one of the most prolific dragons in captivity and the most prolific outside of Indonesia. This latest reproductive event was confirmed through genetic testing as a case of parthenogenesis rather than delayed fertilization.

Source: Prague Daily Monitor, 19 August 2011; 31 August 2011

Komodo Dragons Hatch at Los Angeles Zoo

A total of 21 Komodo dragon eggs hatched at the Los Angeles Zoo in August 2011. The offspring are currently being housed off-exhibit. Plans for the offspring have not been announced.

Source: Huffington Post, 13 September 2011

ARTICLES

Biawak, 5(3), pp. 36-40

Preliminary Account of the Clouded Monitors (*Varanus bengalensis nebulosus*) of Ban Truem Village, Northeastern Thailand

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Abstract - Monitor lizards are the most loathed animals in Thailand. In that respect, Ban Truem Village in northeastern Thailand is a unique exception because its Gui inhabitants respect and revere monitor lizards and regard them as manifestations of their ancestors. This reverence has both religious and traditional facets. They do not eat, harm or harass monitor lizards, in spite of the fact that the monitors regularly prey on chicken eggs and chicks of the villagers. Several aspects of the biology of Ban Truem monitors are discussed: seasonal activity patterns, population size, socialization and communal hibernation.

Four species of monitor lizards are native to Thailand: the rough-necked monitor (*Varanus rudicollis),* the harlequin monitor (*V. dumerilii*), the water monitor (*V. salvator*) and the Bengal monitor (*V. bengalensis*, see below). Until recently, the distribution areas of the first two species were believed to be restricted to southern Thailand (*e.g.*, Cox et. al., 1998; Lauprasert & Thirakhupt, 2001), but more recent studies (Cota *et al*., 2008; M. Cota, pers. comm.) report that the distribution areas spread further north, i.e. *V. dumerilii* – up to northern Kanchanaburi Province, and that of *V. rudicollis* – up to southern Tak Province. *Varanus salvator* is distributed mainly in southern and central Thailand (Cota *et al.*, 2009), and *V. bengalensis* is distributed throughout Thailand (Cox *et. al*., 1998; Lauprasert & Thirakhupt, 2001).

This account concerns the Bengal monitors that live in the area of Ban Truem Village in northeastern Thailand. The Bengal monitors of Thailand belong to the subspecies *V. bengalensis nebulosus* (Mertens, 1942, 1959), commonly known as the clouded monitor, probably due to its speckled pattern. Böhme & Ziegler (1997) suggested upgrading the clouded monitor to full species status, *i.e. V. nebulosus*, but Pianka (2004) still refers to the clouded monitor as *V. b. nebulosus*.

Monitor lizards are the most loathed animals in Thailand. Due to their widespread unpopularity, most Thais do not consider monitor lizards as worthy animals for protection and conservation, though legally, all four species of Thai monitors are protected by the Wildlife Reservation and Protection Act of 1992 (Cota *et al*., 2008). However, the aversion that Thais feel towards monitor lizards and their legal protection do not prevent them from consuming them as bush meat, and clouded monitors may occasionally be found for sale in local food markets, especially in northeastern Thailand. I have never seen evidence that other *Varanus* species are consumed as bush meat in Thailand, but there are reports that they are hunted for either their meat or skin (e.g., Cota *et al*., 2008).

Ban Truem Village is located in Surin Province, Sikhoraphum District, Truem Sub-district, in northeastern Thailand, ca. 450 km northeast of Bangkok. Ban Truem is inhabited by the Gui people - a minority group belonging to the Mon-Khmer lineage. Regarding the widespread unpopularity of monitor lizards in Thailand, Ban Truem is very exceptional in that respect because its inhabitants are respectful and sympathetic to clouded monitors. The Gui people of Ban Truem revere clouded monitors and regard them as manifestations of their

ancestors. According to their belief, the spirits of their ancestors dwell inside the bodies of clouded monitors. Hence, they refrain from killing, eating or harassing the monitors. Even though the monitors regularly prey on chicken eggs and chicks of the villagers, they do not harm or chase them away. According to their belief, if a Ban Truem Gui kills or eats a clouded monitor, he or she is doomed to suffer from an abrupt and serious illness and die shortly thereafter, as has allegedly already happened several times in the history of Ban Truem (attributed to the Guis' belief).

The positive attitude of Ban Truem Guis towards clouded monitors is predominantly anthropomorphic and does not always coincide with biological principles or animal welfare ethics. For instance, according to their belief, if Ban Truem Guis misbehave socially, or if human relations within their society deteriorate - with frequent disputes and confrontations - it is likely to irritate the ancestors' spirits and cause the clouded monitors to emigrate from Ban Truem and settle elsewhere, usually in another Gui settlement in the neighboring Srisaket Province. If the monitors disappear from the village, or if their numbers dwindle, the villagers are doomed to suffer from disasters, misfortunes and hardships. In one such case, the emigration of monitors was followed by a severe drought that caused the rice plants in the rice paddies to dry out and die, which brought about famine and hardships. After a representative monitor was ceremonially returned to Ban Truem in a traditional oxen cart and the monitor population was reinstated in the village, the drought subsided and prosperity returned to the village. Many years later, in a somewhat similar case, a representative monitor was returned to the village from Srisaket Province in a truck, despite warnings of the local psychic that monitor lizards despise modern motorized vehicles and prefer to travel by traditional oxen carts. The monitor was placed in a carton box and then loaded onto the truck, but it succeeded in sneaking out of the box and escaped to the fields. The monitor's absence was discovered shortly thereafter, and the villagers succeeded in tracking it down and recapturing it. This time, it was bound with rope and reloaded onto the truck, all of which was even more sinful. Consequently, one of the tires exploded, causing the driver to lose control of the truck. The incident resulted in two dead passengers, and four others that were seriously injured and rushed to the hospital. Nevertheless, after the monitor was released in Ban Truem and the monitor population re-established itself, prosperity returned to the village (C. Wanasri, unpub.).

By Thai criteria, Ban Truem is an old village. The village was established in 1824 (J. Bunjung, pers. comm.), but the first Gui settlers probably arrived in the area of Ban Truem much earlier (B. Khatchamai, pers. comm.). Today, Ban Truem is a large and highly developed village, and its economic condition is reasonably good. There are two schools in the village (a primary and a secondary school) that are well-managed and adequately equipped, a sub-district administration center equipped with computers and other modern office-equipment, and a parking lot with several passenger cars. Officially, all inhabitants are Buddhists, and there is also a Buddhist temple in the village, but most, if not all of the villagers adhere to animism in which the monitor lizards play a major role. In the village there are several small shrines (called "Po-Jua" in the Gui language) dedicated to monitor lizards, but contrary to spirit houses, city pillars and other types of shrines that are prevalent in many households and neighborhoods throughout Thailand, the *Varanus* shrines of Ban Truem are not looked after meticulously and look dreary and unappealing (Fig. 1).

Surindra Rajabhat University (SRRU) is planning an interdisciplinary research project on the Ban Truem monitor-phenomenon. The research will encompass both biological and anthropological aspects of the phenomenon, and in the future, it will probably involve graduate students as well as faculty members. I was appointed as the coordinator and supervisor of the project. In that framework, I have made several trips to Ban Truem Village.

Altogether, I visited Ban Truem six times; all visits were made during the cold season (November-February). Except for two instances (see below), I did not see monitors or their tracks, but I talked to many villagers. The people I talked to were of various educational backgrounds, hence there were various degrees of reliability concerning the accuracy of the information given. The villagers claim that the monitors hibernate during the cold season, though it is not total hibernation and a single monitor may seldom be seen walking around the village, or even foraging. Although he did not provide details on the locality, Auffenberg (1994) reported that during the cold season, *V. bengalensis* do not forage, and only emerge from their burrows to move to basking sites 1-2 m from the burrow's mouth.

Regarding the aforementioned two instances, during my first visit to Ban Truem (22 January 2008), I saw several caged monitors and several others that were walking around in the immediate vicinity of the cage. The latter group had probably been released from the cage prior to my arrival (though I was unable to confirm this). Both groups looked lethargic and sluggish - untypical

Fig. 1. Monitor lizard shrine in the Ban Truem Village. The adjacent tamarind tree-trunk (at the right, in front of shrine) contains a hibernation tree-hole of clouded monitors. The green leaves belong to a sacred fig (*Ficus religiosa*) strangling the tamarind tree (see text below).

of *V. bengalensis*, which is an active and agile species. Hence, I suspect that both groups were pulled out of their hibernation sites. In respect of animal welfare ethics, this is a despicable act, but I could neither confirm, nor rule out this suspicion. As for the second instance, on 21 December 2010 at 1030 h (air temperature - 31 °C), I saw a sub-adult *V. bengalensis* (ca. 45 cm in total length, estimated from a distance) on the side of the road leading to Ban Truem. While trying to approach the monitor for a closer photograph, it dashed into a thicket, then dove into a nearby water canal, crossed the canal to the other bank, and disappeared from sight. Contrary to the aforementioned group that looked lethargic and sluggish, this individual appeared healthy and was active and agile.

According to the villagers, the monitors hibernate or reduce activity during the cold season, and also aestivate or reduce activity during the hot season (March to mid-May). With regards to hibernation, thermally, this is interesting because there is no need to hibernate - the cold season is as warm as the Mediterranean summer, though nighttime and early morning temperatures may occasionally drop to 15 °C (pers. obs.). Hence, the hibernation or aestivation of the monitors might be related to dry conditions or to food availability (or both) rather than thermal requirements – during the rainy season (mid-May to October) wildlife (especially amphibians) is much more abundant (pers. obs., see below). This assumption is supported by Auffenberg (1994) who found that in Haliji Lake, Pakistan, Bengal monitors are more abundant during the rainy season due to the abundance of insects. In that respect, it would be interesting to compare the Ban Truem monitors to conspecifics in the central, and especially southern parts of Thailand that are more equatorial and less seasonal. Aufenberg (1994) divided the activity and inactivity of *V. bengalensis* during the cold season in different regions throughout its distribution area into four categories (descending levels of latency): (1) Hibernation (Quetta, Pakistan); (2) Brumation (Lahore, Pakistan); (3) Reduced activity (Bombay, India); (4) Year-round activity (Madurai, India), but he did not elaborate on the characteristics of these categories. However, Auffenberg (1994) also reported that in northern India, even during the most appropriate weather conditions for *V. bengalensis* activity, only 10-12% of the local monitors

were active each day (0% in the cold season to 20% max. in the rainy season). Regarding prolonged periods of inactivity during the dry hot season, Auffenberg (1994) claimed that it may occur only in the most xeric parts of the distribution area of *V. bengalensis,* and according to his observations, inactivity never lasted more than 18 consecutive days. Hence, he did not regard this latency as true aestivation.

The factors that control the seasonal activity patterns and the mechanisms in which they act are still unknown, *i.e.*, endogenous biological clocks or stimulus-response reactions to environmental cues, or both. If stimulus-response reactions play the major role in controlling seasonal activity patterns, future eco-physiological studies will probably focus on what environmental cues are involved and how they trigger or suppress activity. Another interesting aspect is whether the various population subgroups (*i.e.*, adults, juveniles, males, gravid and non-gravid females) differ in their seasonal activity patterns, as has been reported for *V. griseus* in the southern coastal plain of Israel (Stanner & Mendelssohn, 1991).

According to the villagers, the monitors are seen everywhere during the rainy season, and the villagers estimate their population size in the thousands. If this is true, it is sensational, but I am skeptical that Ban Truem Village has the carrying capacity for supporting such a large population of clouded monitors. Auffenberg (1994) estimated the average insect consumption of an average-sized *V. bengalensis* to be 5 g/day (hence, for a population of 1000 monitors - 5 kg/day), but his estimate was based on the theoretical food consumption of insectivorous lizards (Avery, 1971) and not on the results of his field study. For captive adult *V. bengalensis*, Auffenberg (1994) found that the mean total weight of food eaten before satiation was 161 g and 100 g for males and females, respectively (9% and 6% of the mean body weight, respectively). However, variability in food intake was considerable, 68-496 g for males, or a maximum of 18% of body weight (all the above-mentioned calculations of Auffenberg were rounded to the nearest gram and nearest percent). Based on his field work, Auffenberg (1994) concluded that such a large prey/predator weight ratio is rarely achieved in the field, and when it occurs, it is probably due to vertebrate prey. In any case, considering the above-mentioned food intakes, it is plausible to assume that the food consumption of a population of 1000 monitors is probably higher than 5 kg/day, and I am skeptical that such an amount of food is available for the monitors - either farm-food resources (*i.e.*, chicken eggs and chicks) or wild/pest prey (*e.g.*, mice, rats, rice-field rodents, amphibians, reptiles, birds and various invertebrates).

The villagers also claim that the population includes all size-classes - from very small juveniles to very large adults, which is also interesting and might indicate a viable monitor population. Conservation-wise, the study of population parameters such as population size and density, sex ratio, age distribution, natality, mortality, immigration, and emigration are of utmost importance. Hence, I shall recommend using micro-chip implants for individual identification of monitors as a part of a long-term study of the population, as well as radio-telemetry for a more comprehensive ecological study.

Another aspect of the monitors' biology that is zoologically intriguing is the possibility of socialization among the Ban Truem monitors. According to the villagers' reports, many monitors bask together on the branches of a large tamarind tree (*Tamarindus indica*) located in the center of the village, which might indicate a considerable social tolerance. Monitor lizards are known to be solitary animals; however, in special circumstances (especially in anthropogenic conditions) solitary animals may display certain social patterns such as hierarchy, as clearly seen among stray urban cats gathering around food resources. Subba Rao and Rao, (in Auffenberg, 1994) reported on six to seven Bengal monitors that were feeding simultaneously on the carcass of a Sambar deer, which is also indicative of a social tolerance and probably involves social mechanisms of one type or another.

Another interesting aspect that I heard from the villagers is that the monitors use communal hibernacula - a well-known phenomenon that has been documented for several North American snakes (*e.g.*, Gregory, 1984), but never recorded for monitor lizards. One of the village elders, a previous headman of the Truem Sub-district, pointed to a tree-hole ca. 5 m up the trunk of a large tamarind tree located in the center of the village, and said that about 100 monitors hibernate inside it (Fig. 2). I later returned with a ladder and a flash-light, and climbed up to the hole opening. The hole appeared empty, though I cannot be absolutely sure of that, as it was a ca. 2 m deep hole down the trunk, and side tunnels may well have branched from the bottom of the hole or from its walls from hidden spaces. No indirect evidence of the monitors' use of the hole (shed skin, signs of extensive scratching on the trunk or wear around the entrance to the hole) was found.

Acknowledgments - Achara Phanurat initiated the Ban Truem monitor lizard research project, and Surindra

Fig. 2. Hole opening in a tamarind tree in the Ban Truem Village, in which monitor lizards are claimed to hibernate. The green heart-shaped leaves belong to a sacred fig (*Ficus religiosa*) strangling the tamarind tree.

Rajabhat University supported this preliminary survey. Michael Cota lent me a book from his private library and gave me useful information on Thailand's herpetofauna. Their contributions and help are gratefully acknowledged.

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Notes on the Malaysian "Black Dragon"

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Abstract - Some details are given on the collection of a large melanistic varanid lizard from southern Malaysia and its introduction to the live reptile trade.

In 2006, a shipment of large melanistic varanid lizards was imported into the United States from Malaysia. Some of these specimens were initially displayed and offered for sale at the North American Reptile Breeder's Conference in Daytona Beach, Florida in August of that year. Labeled as "black dragons" (Fig. 1.), these animals strongly resembled a melanistic population of water monitor described from Southern Thailand as *V. salvator komaini* (Nutphand, 1987; Fig. 2) and later synonymized with *V. salvator macromaculatus* (Koch et al., 2007), but were purported by dealers to represent a distinct new species. Since this 2006 shipment, additional specimens have entered the live reptile trade in both North America and Japan, and successful captive reproduction of these animals has taken place on several occasions (Dwyer and Perez, 2007a,b). Yet, despite knowledge of certain biological parameters (Dwyer and Perez, 2007a,b) and familiarity with these animals in captivity, nothing

Fig. 1. Captive "Malaysian black dragon", Parque Reptilandia, Costa Rica. Photograph by **Robert Mendyk**

Fig. 2. Melanistic *Varanus salvator macromaculatus* (captive) from southern Thailand. Photograph by **Michael Cota**

has been reported about their discovery, origin, or taxonomy.

While the label "black dragon" was originally used by Nutphand (1987) for melanistic animals from Thailand, this name was more recently applied to Malaysian specimens by Tog Tan, a live reptile dealer who operated out of Kuala Lumpur, Malaysia and is responsible for introducing these animals to the live reptile trade. When Tog Tan passed away in June 2009, much of what he had learned about these animals including their precise locality was lost. However, some relevant information was resurrected from old emails and unpublished notes of his, as well as from personal accounts generously provided by family members.

During a trip to collect gravid reticulated pythons (*Broghammerus reticulatus*) in southern Malaysia around 2003/2004, Tog Tan discovered several large melanistic varanid lizards for sale at an animal market in a remote area of Johor (location not specified). After initially bringing back several specimens to his facility in Kuala Lumpur, he made several more trips to Johor over the next few years to collect and secure additional specimens (Figs. 3 & 4). Out of a total of 86 specimens collected, at least 30 were exported to a dealer in the United States, 24 were loaned to a reptile park in Perlis (Fig. 5), and several others were purportedly sold to a governmental outfit.

Tog Tan noted that these melanistic animals attained larger proportions than other Malaysian varanid lizards (Fig. 6), including the common *V. salvator macromaculatus* found throughout Peninsular Malaysia, with the largest individual collected purportedly measuring close to three meters in total length. Although Tog Tan collaborated with herpetologists about the possibility of describing these animals as a new species, it is unclear whether any specimens with precise locality data were ever deposited in a museum collection or if they even represent a distinct taxon, and to date, no such description has materialized.

Figs. 3 & 4. Captive "black dragons" collected by Tog Tan. Photographs courtesy of **Stefanie Tan**.

Fig. 5. Tog Tan with "black dragons"sedated in preparation of delivery to a reptile park in Perlis. Photograph courtesy of **Stefanie Tan**.

Discussion

Although a precise locality for these animals could not be determined, based on the information obtained from Tog Tan's unpublished records, it appears that these animals originate from Johor, southern Malaysia. Dwyer and Perez (2007a) mentioned Kukup as a potential locality for these animals within Johor; however, this locality has yet to be confirmed. Despite its close resemblance to melanistic *V. salvator macromaculatus* from Southern Thailand (= "komaini")

Fig. 6. A large male "black dragon" collected by Tog Tan. Photograph courtesy of **Stefanie Tan**.

Fig. 7. *Varanus salvator macromaculatus* from Kuala Lumpur. Photograph by **Robert Mendyk**.

in both morphology and coloration, this Malaysian population occurs several hundred kilometers to the south, and the two are separated by populations of *V. salvator macromaculatus* that exhibit distinct markings (Fig. 7). Further investigations are needed to pinpoint a precise locality for these animals as well as determine whether they represent another melanistic population of *V. salvator macromaculatus* or a distinct taxon.

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Biawak, 5(3), pp. 44-47

Burrows with Submerged and Water-filled Entrances and Nocturnal Retirement of *Varanus salvator macromaculatus* in Thailand

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Abstract - Use of burrows that are completely submerged or lead directly under water has never been documented in *Varanus salvator*. In this report, *Varanus salvator macromaculatus* is documented emerging from a burrow with an underwater entrance, as well as using burrows with entrances leading directly underwater. Further refuge sites are identified where the entrances were partially submerged, and nocturnal sightings and night-time refuges are also discussed.

Introduction

Use of burrows by *Varanus salvator* has only been documented in any detail by Traeholt (1995), although the use of burrows by some other monitor species is well documented: *V. emerius* (Pianka, 1968); *V. griseus griseus* (Stanner & Mendelsohn, 1987, 1991; Tsellarius *et al.*, 1991; Tsellarius & Menshikov, 1995; Stanner, 2007); *V. gouldii* (Green & King, 1978); *V. komodoensis* (Auffenberg, 1981); *V. bengalensis* (Auffenberg, 1983, 1994; Tsellarius *et al.*, 1991; Bennett, 1992; Tsellarius & Menshikov, 1995); *V. mertensi* (Mayes, 2007); *V. exanthematicus* (Bennett & Thakoordyal, 2003).

Traeholt (1995) described a number of *V. salvator* burrows located on flat land and river banks that were above the water level and partially flooded. To date there has been no documentation of any monitor lizard using a burrow with an entrance that is under water or one that immediately leads under water from the entrance. This report provides additional information on burrow usage of *V. salvator*, by describing submerged burrows and burrows with water-filled entrances used by *V. salvator macromaculatus* in Thailand.

Burrow with submerged entrance

An adult *V. salvator macromaculatus* was observed exiting a burrow with an underwater entrance at Lumpini Park, Bangkok, Thailand. The observation was made in the mid-afternoon after 1500 h, at a time when activity increases after the hottest part of the day has passed. The animal was first observed with its head out of the water, with over half of its body still inside the burrow entrance. While observing the surrounding area, it spent some time with at least part of its body inside the burrow (Fig. 1). Judging from the position of the head and neck, the entrance to the burrow was between 10 and 20 cm beneath the surface of the water. Further investigation of the burrow was not made and would not have been possible without permits. Given its location, this burrow entrance is believed to remain under water year-round. The waterways of Lumpini Park are connected to canals that run through Bangkok, which are connected to the Chao Phraya River. Water levels at Lumpini Park are relatively stable and do not fluctuate with the tides of the nearby Gulf of Thailand which cause the Chao Phraya River to rise, nor do they fluctuate during the rainy season when prolonged torrential rains sometimes cause the Chao Phraya River to flood other sections of Bangkok. The water levels of canals in Bangkok are controlled by a series of floodgates.

Burrows leading underwater

At Bangkok's Dusit Zoo, multiple burrows with entrances leading immediately underwater are used by

Fig. 1. *Varanus salvator macromaculatus* emerging from an underwater burrow entrance. Photograph by **Michael Cota**.

free living *V. salvator macromaculatus*. In some of these burrows, water came up to the surface and the burrow led nearly straight down (Fig. 2). Other burrows went down 20 to 30 cm into the ground before reaching water. There are also underground burrows that lead into and out of the waterways of the Dusit Zoo. The water levels here are relatively stable for the same reasons that they are stable at Lumpini Park, and the Dusit Zoo is also not subject to flooding.

Partially submerged refuge entrances

At both Lumpini Park and the Dusit Zoo, many *V. salvator macromaculatus* can be seen entering large, partially submerged concrete pipes and underground waterways to take refuge in the evenings, from before sunset to a point between sunset and twilight. It is not known if these monitors remain in the water all night or if there are areas in these underground waterways where they can get out of the water.

In the water overnight

Many *V. salvator macromaculatus* were found at night in the water along the sides of flooded swampy areas dominated by 2 m+ elephant grass in fragmented natural habitats of the Chao Phraya River flood basin. These areas are broken up by cultivated rice fields, rice fields that are no longer in use, orchards and villages. When disturbed from their sleep, all individuals rushed deeper into the flooded area for many meters before stopping. No further movements were observed in any of these individuals and it is assumed that they spent the remainder of the night at that location.

Other nocturnal locations

Mangrove forests are subject to significant tidal fluctuations, which would cause burrows to become completely submerged during high tides. No burrows large enough for even an adolescent monitor were observed in mangrove forests, and all *V. salvator macromaculatus* encountered at night in these areas were seen on the trunks of trees, up in trees, or at the edge of waterways running through the mangroves. The waterways of the mangroves are generally still, but currents move in and out slowly with the tides. *Varanus salvator macromaculatus* is usually absent from areas with fast moving currents.

In primary forest habitats such as moist evergreen forests and dry evergreen forests, *V. salvator macromaculatus* were also observed at night on the trunks

Fig. 2. *Varanus salvator macromaculatus* entering a burrow that immediately leads under water. Photograph by **Michael Cota**.

of trees in waterways, on large tree limbs, and in the water along the banks of waterways. Although there are many burrows in the forest, *V. salvator macromaculatus* have not been observed using them.

Nearly all hatchling and juvenile *V. salvator macromaculatus* observed in Thailand over the period from 2004-2011 were encountered in standing trees or trees that have fallen at the side of waterways. Although no observations of hatchlings and juveniles were made at night, individual hatchlings, and in one case a pair of hatchlings (Fig. 3), have been observed emerging from small tree hollows and fallen trees alongside waterways in the morning. One juvenile that was observed for several days never ventured more than 2 m away from its refuge (Fig. 4).

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Fig. 3. Hatchling *V. salvator macromaculatus* emerging from a small tree hollow in the morning. Photograph by **Michael Cota**.

Fig. 4. Juvenile *V. salvator macromaculatus* which stayed within 2 m of its refuge in a fallen tree over the course of three days of observations. Photograph by **Michael Cota**.

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HISTORICAL FACSIMILES

The following reprint is an excerpt from W. Saville-Kent's 1897 book entitled "The Naturalist in Australia", which highlights and describes the Australian varanid lizards he encountered during his 12 year tenure as Australian Commissioner of Fisheries. Saville-Kent's descriptions of varanid natural history and behavior, particularly that of *Varanus varius*, as well as captive husbandry and the display of varanids in zoological gardens make this work an important early contribution to the study of varanid lizards. Questionable personal anecdotes on varanid behavior further add an entertaining dimension to this work. While only four pages of the book are dedicated to varanid lizards, the remaining 298 pages offer a unique and exciting early look at the flora and fauna of Australia through the eyes of a 19th century naturalist.

- RWM

Saville-Kent, W. 1897. The Naturalist in Australia. Chapman & Hall Ltd., London. Pp. 94-97.

The Naturalist in Australia

W. SAVILLE-KENT

Among the numerous varieties of Lizards kept in temporary confinement by the writer, no others proved themselves so amenable to humanizing influences as the several types previously described and illustrated. Several examples of the Australian Monitors or Varani, locally dubbed "Goannas", and of species pertaining to the genus *Grammatophora*, fell thus within the author's purview. Of one of these Monitors or Varani, *Varanus varius*, popularly known also as the "Lace Lizard", with reference to its skin markings, that came into the author's possession at Brisbane, Queensland, a little anecdote may be appropriately related. The specimen was a handsome one, adorned throughout its body and limbs after its kind with a complex reticulated pattern, and having its throat resplendent with interblending tints of sky blue and lemon yellow. He was at the best of times a sulky animal and, though he fed well, repulsed all friendly overtures and continually strove to make good his escape from the extemporized cage provided in the garden for his occupation. One night his efforts proved successful, and after vain though patient searchings he was reluctantly given up for lost. The astonishment that was experienced ten days later may be better imagined than described, when the returned prodigal was seen in a very emaciated and dilapidated condition, struggling vehemently to regain access to his former prison-house. During his voluntary absence he had evidently fallen upon evil times, possibly been surprised after the manner of his tribe, in robbing a henroost and so narrowly escaped the wrath of an avenging Nemesis as to receive on his hinder quarters a blow that was doubtless intended for his head, and which, had it attained its mark, would have brought its career to a speedy and ignominious termination. The fact that he returned minus his long, handsome tail, which had apparently been chopped off at the very stump, lends substantial support to the foregoing tentative interpredation. The most interesting point in the episode is the circumstance of the creature's voluntary return to captivity, associated with which he probably carried in his brain the reminiscence of a more liberal dietary than fell to his lot in the outer world.

On relating this anecdote of the truant *Varanus* recently to Dr. G.D. Haviland, that naturalist informed the writer that he had had a very similar experience with a member of the same genus in North Borneo. A captive specimen in his possession similarly made good its escape, and after an absence of four or five days returned to some of its internment, having evidently a preference for the "flesh-pots of Egypt", albeit accompanied by durance vile, to freedom and a precarious commissariat in his native jungle.

Certain of the Australian Monitors attain to very considerable dimensions, and are by no means desirable subjects to encounter at close quarters with unprotected hands. The writer possesses a skin of *Varanus varius*, previously referred to, from the Eucalyptus forests of Gippsland, Victoria, which measures over seven feet in its total length, and has claws attached that are as formidable as those of a large tiger cat. Even smaller examples, such as the one signalized in the foregoing

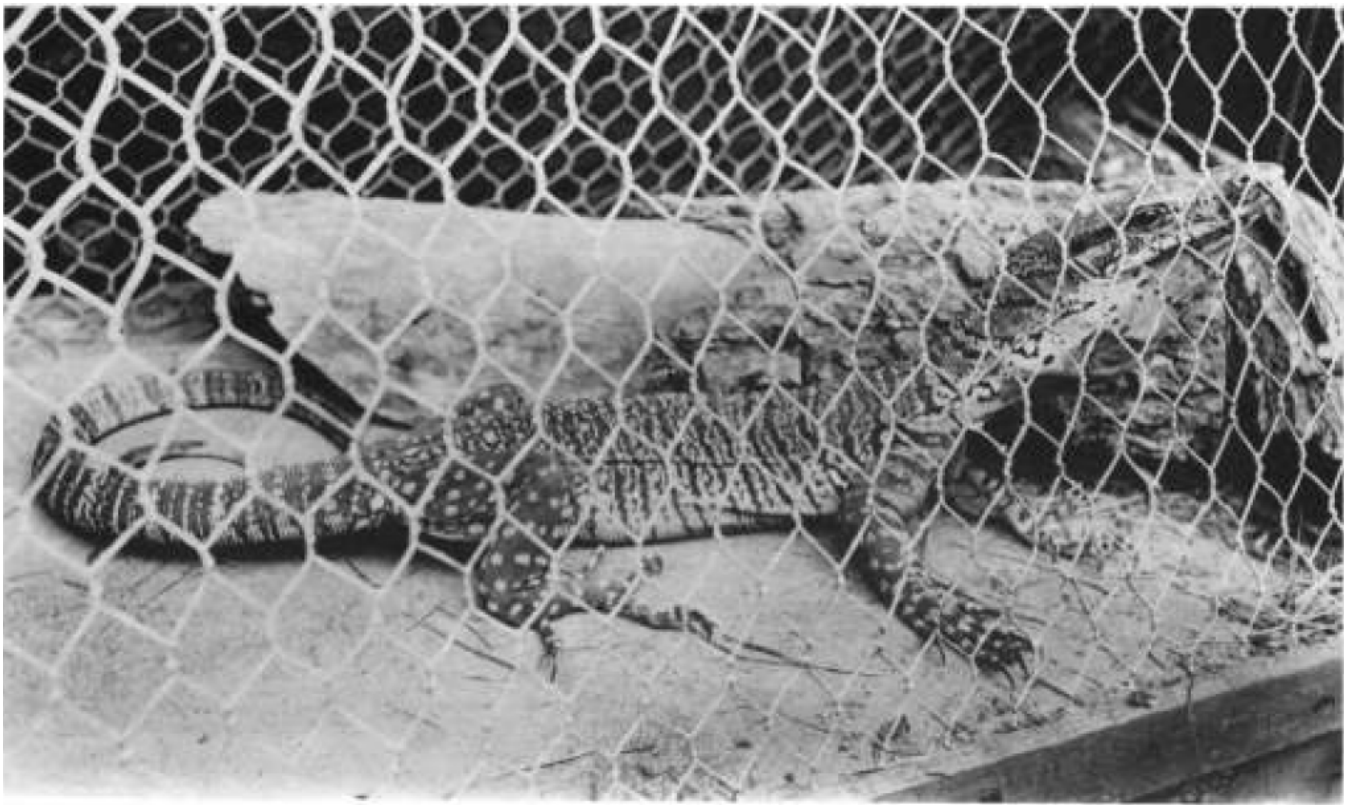

Plate XIV. Australian Monitor or Lace Lizard, *Varanus varius*. Quarter natural size, p. 94.

anecdote, which, previous to curtailment, measured a little over three feet, could use its hind talons to such effect that an incautious attempt to pick it up on the occasion of the "prodigal's return", resulted in the most gruesome scarifying of the hands of the experimenter. The species of *Varanus* here referred to is an essentially arboreal type, preying to a large extent, in its adult state, on the opossums and their young, to whose holes, high up in the hollow gum-trees, they will lay patient siege until the poor victims, if not otherwise accessible, are starved into surrender. Birds and their eggs, insects, and even lizards of smaller size are all equally acceptable as food to these giants of their race.

Examples of the Lace Lizard are usually on view in the Reptile House at the Regent's Park, including, at the present time, specimens that measure as much as four or five feet in total length. In none of these imported individuals, however, do the bright blue and yellow tints that decorate the throat exhibit the vividness characteristic of specimens fresh from their native "bush". The individual possessed by the author being of too erratic a disposition to be trusted to sit for his portrait in the open, the best had to be made of the opportunities afforded of photographing him through the wire netting of his cage. The most satisfactory of these attempts, reproduced in Plate XIV., suffices, notwithstanding the intervening wirework, to impart a very fair idea of its most characteristic attitude, the natural involute coiling of the tail exhibited by the creature when in complete repose being especially noteworthy. Their tail constitutes with the Monitors a very formidable weapon. It is frequently longer than the body compressed from side to side, and as tough as leather. Independently of its armature of teeth and claws, the animal can by virtue of this appendage transform itself into a sort of animated stockwhip and severely punish incautious aggressors at close quarters. An attendant at the Zoological Gardens was assailed in this manner and had his neck severely lacerated by the tail of one of these reptiles while cleaning out its den, a short while since. Varani skins are, it may be mentioned, extensively utilized nowadays for the manufacture of purses and other "fancy leather" or "Lizard Skin" articles.

There is a species of Monitor, *Varanus giganteus*, allied to the arboreal variety, *V. varius*, that is accredited with attaining to even larger proportions, a length of as much as eight feet having been recorded of specimens from the northern territory of South Australia. The habits of this species are, however, very distinctly amphibious, on which account it was originally referred by Gray to the

genus *Hydrosaurus*. *Varanus*, or *Hydrosaurus salvator*, is another huge Monitor possessing similar amphibious habits and attaining to like dimensions, which, in addition to inhabiting Queensland, is met with in India and throughout the Malay Archipelago. A remarkably fine example of this Monitor, shot by Lieutenant Stanley Flower at Singapore, has been recently presented by him to, and has been admirably set up in, the Zoological Galleries of the British, Natural History, Museum. Excepting to those who may take delight in the society of full-grown crocodiles and alligators, the recommendation of either of the foregoing Australian Varani as household pets would be a matter of supererogation. Large as are the dimensions of these living Monitors, the Australian tertiary deposits have produced conclusive evidence of pre-existing species which very much exceeded them in size. Certain of these, which have been referred to the genera *Notiosaurus* and *Megalania*, would appear to have attained to a length of no less than from fourteen to eighteen feet. A relatively small and handsome species of Monitor, technically known as *Varanus acanthurus*, or the Spiny-tailed Monitor, occurs in tolerable abundance in the north-west district of Western Australia, under conditions corresponding with those which yield the Frilled Lizard, *Chlamydosaurus*. An example of this Monitor was obtained for the writer at Roebuck Bay, and was also brought to England and presented by him to the Zoological Gardens. As with the species kept in Queensland, it always manifested a hostile attitude, attacking and worrying the Chlamydosauri, in which it was at first associated, and repelling all friendly overtures from its keeper. Its arrival in England and participation in the polite society of an innumerable company of other lizards, does not appear to have exercised any ameliorating influence upon this creature's temper, which is as short and uncertain as when it was first captured, now over twelve months ago.

A noteworthy feature in the Varani is their possession in a more readily recognizable degree than in any other lizards of that vestigial structure known as the "pineal eye", a minute functionless median optic organ situated on the top of the head, and intimately connected with the so-called pineal gland. In bygone ages this median eye possibly represented the chief or only optic organ of a doughty race of reptiles to whom the title of the Cyclops would have been both figuratively and literally appropriate. Some admirable dissections of this structure, made by Professor Charles Stewart, F.R.S., may be seen in the Museum of the Royal College of Surgeons.

Forelimb-assisted Extractive Foraging Sheds New Light on the Behavioral Complexity of Arboreal Varanid Lizards

Gifted with impressive problem-solving abilities, varanids have long been recognized as the most intelligent and behaviorally complex group of extant lizards. Most of what has been gathered on their insight, learning capacity, and behavioral complexity has come from investigations and behavioral observations on large terrestrial species, and very little has been reported on these parameters in small arboreal taxa. In this study, a previously undocumented foraging behavior in *Varanus beccarii* which demonstrates exceptional insight, behavioral flexibility, and coordinated forelimb movements is described and experimentally tested.

Through a series of captivity-based experiments, it was discovered that specimens of *V. beccarii* will skillfully insert their forearms into narrow tree holes to extract embedded prey from openings that are too small to enter with the head (Fig. 1). Presumed to be a mutual interaction between insight learning and instinct, this ability of *V. beccarii* will most likely enable it to exploit an ecological niche that may not be occupied by many other foraging predators, diversify its natural diet, and increase the total number of foraging opportunities.

Also presumed to occur in other species belonging to the *V. prasinus* species complex, forelimb-assisted extractive foraging in *V. beccarii* calls special attention to the behavioral complexity and flexibility of this often

Fig. 1. Forelimb-assisted extractive foraging in *Varanus beccarii*. Photograph by **Robert Mendyk**.

overlooked group of varanids, and may stimulate future research on the intelligence, behavioral complexity, and learning capacity of the group. This study also has important implications for captive management, where enrichment stimuli designed to encourage extractive foraging could be used to enrich the lives of specimens maintained in captivity.

Correspondence and feedback concerning extractive foraging in additional species of *Varanus* are welcomed and encouraged from zoos, researchers, and private monitor keepers. Video documentation of forelimb-assisted prey extraction behavior in *V. beccarii* is available upon request.

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