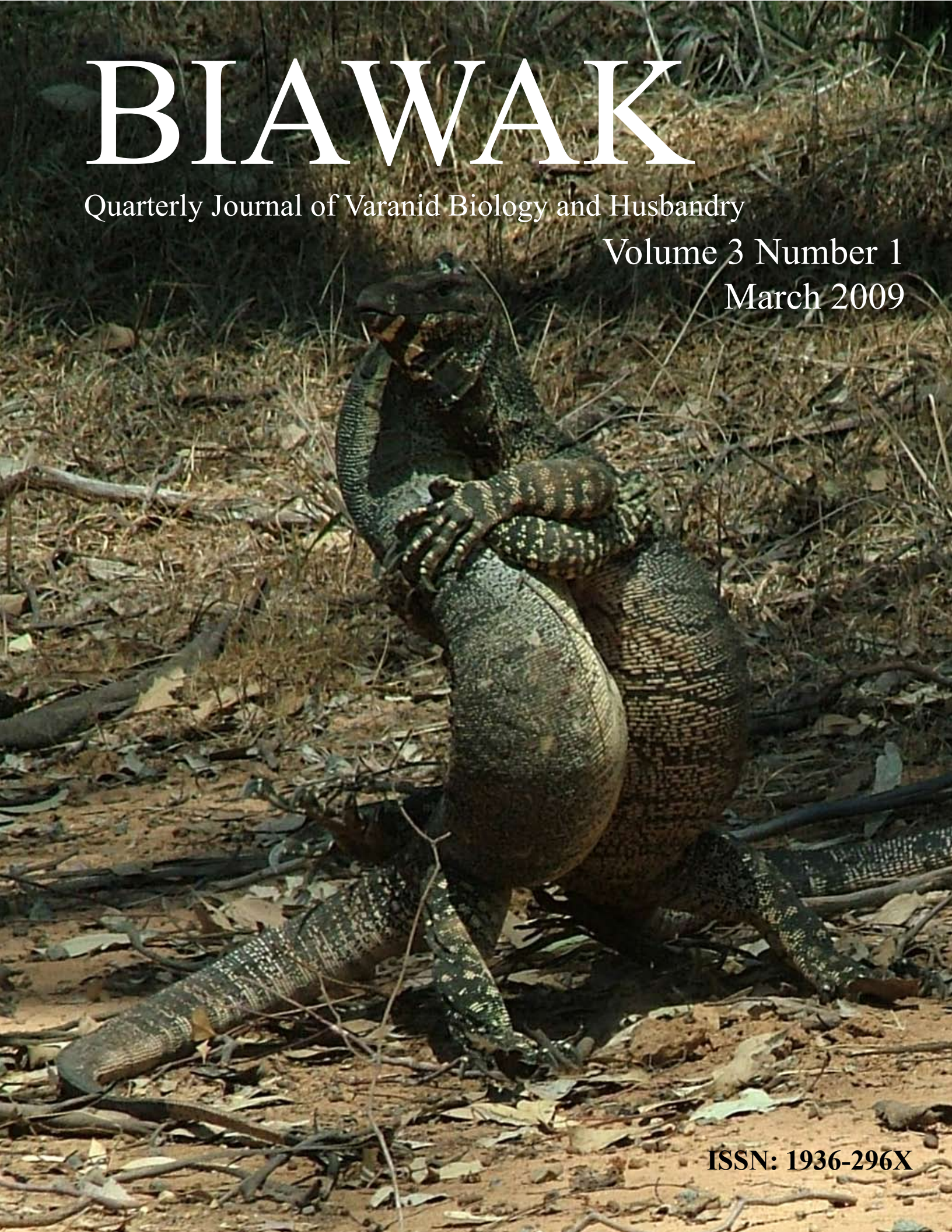
BIAWAK

Quarterly Journal of Varanid Biology and Husbandry

Volume 3 Number 1
March 2009



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Cover and Inset: *Varanus varius*

While driving on a dirt road ca. 5 km north of Culcairn, NSW (ca. 35°37'20"S ; 147°2'39"E) at around 1155 h on 21 October 2007, two adult *Varanus varius* (each ca. 1.2 m in total length) were spotted at the side of the road near the base of a eucalypt, engaged in ritualized combat with one individual on top of the other. After about five minutes of struggling and changing positions, often raised on their hind legs and supported by their tails, the combat ceased suddenly. One individual ran off, while the other climbed the tree at the base of which they had been combating. Based on a comparison of body markings, it is clear that the victor, the monitor that ascended the tree, was on top of its opponent when first sighted, and managed to force itself on top of its rival at least four times over the course of the observation. Inspection of the images shows that both animals sustained some lacerations to their bodies.

A comment on the images from the photographer's point of view: In the usual tiresome way of wildlife in nature, the monitors were combating in partial shade against a mottled background. It couldn't be helped as my son, who was learning to drive at the time, had unfortunately somewhat 'overshot' the location. I was not going to get out of the car as I was afraid of disturbing them, so only shot through an open car window from about 15 m away using the maximum optical zoom of a Fuji FinePix S7000.

About the photographer: **Dirk HR Spennemann** (dspennemann@csu.edu.au) is an Associate Professor in Cultural Heritage Management with the Institute for Land, Water and Society at Charles Sturt University, Albury, and is actively engaged in the photo documentation of cultural heritage properties and cultural landscapes. In a cross-over from his academic work Dirk has been interpreting the past in a more artistic fashion as well. His first solo exhibition, "Echoes of the Past, Visions of the Future",was shown in Albury (NSW), Temora (NSW) and Tanunda (SA) and will be travelling to Hahndorf (SA) and Wagga Wagga (NSW) later in 2009. His photography can be accessed via www.ausphoto.net.

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INTERNATIONAL VARANID INTEREST GROUP
www.varanidae.org

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 panoptes rubidus. near Lake Ballard, WA. Photograph by **Maureen Pierre** maureenpp26@hotmail.com

ORGANIZATIONAL NEWS

New Additions to the Editorial Board

The IVIG welcomes distinguished varanid researcher Hans-Georg Horn to the editorial board of *Biawak* as editorial reviewer. Also welcomed to the editorial board as editorial liaisons are Arnaud Colin, president of Le Groupement d'Etude des Varanidés, and John Adragna, director of cybersalvator.com, an online informational resource dedicated to the *Varanus salvator* complex.

Seeking Zoo Liaisons

The IVIG is currently seeking motivated individuals from North American, European, African, Asian and Australian zoological institutions to join the editorial board as zoo liaisons. Primary duties will include networking with zoological institutions to report quarterly announcements of recent varanid captive breedings as well as promoting *Biawak* to herpetology departments in zoos and aquariums in your respective region. For additional details, please contact the IVIG at info@varanidae.org.

Logo Needed for the IVIG

The IVIG is currently seeking an official insignia to represent the organization online, at events, in publications and on organizational documents. Entries should submitted electronically in jpeg format and be no smaller than 2400 x 2400 pixels. The only rigid requirement for the design is that it must include the IVIG's unabbreviated name, "International Varanid Interest Group". The winning design shall be announced and unveiled in a future issue of *Biawak*. Design entries should be submitted to: submissions@varanidae.org
The deadline for submissions has been extended to 15 August 2009.

*Varanus rudicollis.*Bukit Lawang, Sumatra. Photograph by **Dustin McGill**

EDITOR'S NOTE

Changes for the Better...

As you will undoubtedly notice with this current issue, several changes and revisions have been made to the styling and format of *Biawak*. We are confident that these changes will improve the journal, giving it a more professional appearance and presentation. Of course as always, we welcome and encourage comments and suggestions on how to improve the journal from our readers and supporters.

Future Plans for *Biawak* and the IVIG

Several ideas have been proposed regarding future plans for *Biawak* as well as efforts of the IVIG. Here, I'll discuss some of the ideas which have been proposed, although it should be stated that none of these ideas have been confirmed or set into motion.

A Printed Edition of Biawak?

Although not necessarily a new idea, having first considered offering a printed version of *Biawak* at the time of its inception, we have received several requests from supporters to publish a printed version of the journal. While there is no objection to the idea of a printed version of the journal, since many individuals including myself prefer to read from printed material rather than a computer monitor, there does exist the issue of feasibility.

The IVIG currently exists as a volunteer-based organization, having no operating expenses associated with the production, publication or distribution of its journal, aside from a modest $110 per annum for website hosting (which is absorbed by its editors). This has allowed the journal to remain open-access, accessible to anyone with internet access. In addition to the journal *Biawak*, membership to the IVIG also includes open-access to several online varanid literature resources. If we were to proceed with a printed version of the journal, this would offset our current management and operating system, requiring the governance of paid subscriptions, the incurred costs of printing, and postage distribution. This is by no means unattainable, however careful thought must be given to whether or not such a venture would be worthwile and sustainable.

There are not many zoological publications as taxon-specific in its coverage as *Biawak*, reporting exclusively on the genus *Varanus* (although it should be noted that submissions pertaining to *Lanthanotus* may also be considered). Due to logistical constraints, many specialized publications have been limited to online distribution rather than print, with some even still charging for readership. Of course there are several specialized print journals, magazines and newsletters

Varanus salvator courtship. Penang, Malaysia. Photograph by **Nur Hussein**

Varanus tristis orientalis. Magnetic Island, Qld. Photograph by **Stephen Zozaya**

which have been successful and sustainable; one particular serial is the journal *Gekko*, published by the Global Gecko Association (http://gekkota.com).

Historically, the majority of printed varanid serials have not proven to be sustainable or economically feasible. Although the exact causes of their demises each remain somewhat unclear, the serials *VaraNews*, *Dragon News*, *Varanids*, and *Nieuwsbrief van de Nederlandse Doelgroep Varanen* never lasted longer than a few years. Some are said to have experienced problems associated with printing and distribution costs (most, if not all of these publications existed prior to the "internet age", and had no other option besides print). If the IVIG were to pursue a printed version of *Biawak*, how could it avoid similar problems faced by similar varanid publications of the past?

Perhaps the safest approach to offering *Biawak* in print form would be to publish entire volumes as complete book-bound editions, rather than individually-printed issues. This would eliminate many foreseeable problems often associated with the publication of printed serials such as printing delays and distributional/postage issues (especially when dealing with international postage). At the same time, proceeds received through the sale of printed editions could be used to fund in-situ varanid field studies and conservation initiatives, an important long-term goal set forth by the IVIG at its inception.

We encourage feedback from our readers and supporters regarding the prospects of printed editions of *Biawak.* Although it has not yet been determined what a printed edition would cost to publish, we would like to hear your thoughts on whether or not you see this as a worthwile venture, and if you would be interested in purchasing printed volumes if they were offered.

An International Varanid Symposium?

Another idea which has recently been proposed is the possibility of the IVIG hosting a symposium where original varanid research, field observations, captive husbandry and breeding, veterinary medicine, and techniques can be presented in a communal forum. The symposum would feature speakers from the academic, zoo and private hobbyist sectors, with presented papers to be published in a proceedings. Attendees would be required to pay registration fees to help offset the expenses associated with hosting such an event.

The location for such a symposium has not yet been addressed, however given that the three prior "Advances in Monitor Research" symposia have been held in Europe, it is felt that a meeting in North America or perhaps Australia would be a more appropriate venue. To help reduce travel hardships and expenses, it may also be worthwile to schedule the event to coincide with another major herpetological gathering, conference or exposition.

If attending an International Varanid Symposium would be of interest to you, please send us your feedback. Also important to note in your response is your country and city of residence, how far you would be willing to travel (would you consider traveling internationally?), what types of events, workshops or discussions you'd be interested in seeing, as well as any other comments or suggestions you might have regarding such an event.

*All feedback should be sent to **info@varanidae.org**

NEWS NOTES

Malaysian Wildlife Officers Seize 600 *Varanus bengalensis nebulosus*

More than 600 *Varanus bengalensis nebulosus* were seized by Malaysian wildlife officers at the Kuala Lumpur International Airport on 18 December 2008. A Kuala Lumpur man was arrested the following day in connection with the seizure. Several monitor lizards, python meat and skins, and fox meat were found at the man's residence, and if found guilty of smuggling, he faces a fine of 21000 ringgit ($6176 US) and up to 18 years in prison.

Source: Asia-Pacific News, 22 December 2008

2,300 *Varanus bengalensis nebulosus* Confiscated

In January 2009, Malaysian wildlife officials seized 2,300 *Varanus bengalensis nebulosus* purportedly destined for restaurants which serve exotic meats in Malaysia and abroad. Three men were arrested at a storage facility where both live and dead monitors were found in cages.

The monitors are planned to be released back into the wild, although no details have been specified. Activists warn that the illegal trade of endangered animals in Malaysia is thriving because of demand from restaurants in Asian nations which desire exotic meats.

Source: Associated Press, 13 January 2009

Varanus komodoensis Bites Keeper

A keeper at the Virginia Aquarium (USA) was bitten on the hand by a 1.4 m, 9 kg *Varanus komodoensis* in an off-exhibit area of the aquarium. According to the aquarium's curator, the incident is likely the result of a mistaken feeding response. The keeper was treated at Sentara Virginia Beach Hospital, however the extent of the injury was not released.

Source: Associated Press, 19 January 2009

Announcement for the First Annual Meeting of the "AG Warane" of the DGHT:

The first annual meeting of the re-established AG Warane will take place on 18 April 2009 in Hanau near Frankfurt.

The meeting starts at 10 a.m.

Location: Cafe-Restaurant Sandelmühle
Philipp-August-Schleissner-Weg 2a
63452 Hanau

Further information and a detailed schedule of events can be found on the AG Warane homepage at www.ag-warane.de, or contact Kay Uwe Dittmar at dittmar@ag-warane.de.

Varanus gouldii. Bunyeroo Gorge, SA.
Photograph by **Tracy Connolly**

ARTICLES

Biawak, 3(1), pp. 9-17

Garbage Appeal: Relative Abundance of Water Monitor Lizards (*Varanus salvator*) Correlates with Presence of Human Food Leftovers on Tinjil Island, Indonesia

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Abstract - Though considered common throughout the majority of its range in Southeast Asia, the water monitor lizard, *Varanus salvator* has been subjected to hunting pressures in response to global demand for leather products made from lizard skin. Previous research has indicated that *V. salvator* has an extremely broad diet and will scavenge food leftovers from residents and tourists in addition to seeking out live prey. Such indiscriminate eating habits and potential tolerance of close human inhabitation may be one key to the maintenance of population levels as *V. salvator* are increasingly forced to adapt to living in close proximity to humans.

On Tinjil Island off the southern coast of West Java, Indonesia, a study was designed to investigate the effects of human presence on *V. salvator* behavior by comparing relative abundance of monitor lizards in areas of human habitation to areas in which humans do not reside or prepare food. In the absence of hunting pressure by humans it was hypothesized that *V. salvator* would be attracted by the possibility of scavenging food leftovers, thus increasing the relative abundance of monitors in inhabited areas where human food preparation was common. The results of the study showed a statistically significant difference ($p<0.0001$, Poisson test) in relative monitor lizard abundance of the two areas, with an average approximate abundance of 4 specimens/km^2 in uninhabited areas (where human food leftovers were not available) as compared to 1400 specimens/km^2 in areas inhabited by people.

Introduction

Indonesia is home to several varanid species (Böhme, 2003) and of these, water monitor lizards (*Varanus salvator* spp.) inhabit numerous islands (Koch et al., 2007). Historically, large lizards such as *Varanus salvator* have been heavily utilized by indigenous people, who have traditionally used lizard meat as a source of food and lizard skins for domestic and ceremonial purposes. For thousands of years such patterns of use have been sustained, due to low human density and little degradation of suitable monitor habitat (Green and King, 1993). In the recent past, however, international demand for lizard skins has increased, reaching a high in 1994 with an estimated 2-3 million varanid lizards killed worldwide (Jenkins and Broad, 1994). Large lizards are caught, killed, and skinned in their country of origin, with the skins exported to other parts of the world as the base material for high-quality leather goods. Due to its relative abundance, large size, and suitable skin, *V. salvator* has been the most heavily exploited lizard species in the international leather trade, with an estimated 600,000 to 1.5 million specimens taken from Indonesia for the leather industry in 1990 alone

(Luxemoore and Groombridge, 1990). With Indonesia's establishment of annual export quotas beginning in 1995, lizard skin exports have appeared to decrease, though records ranged widely with 356,000 to 700,000 skins exported annually from 1993-2001 (TRAFFIC and the IUCN/SSC Wildlife Trade Programme, 2004). Though clearly of less impact with a reported 2,300-6,600 live specimens exported annually during the same time period (TRAFFIC and the IUCN/SSC Wildlife Trade Programme, 2004), live capture of *V. salvator* for food and pet trade is also considered a factor when reviewing overall species activity.

Though shown to have a preference for live prey, *V. salvator* will also opportunistically scavenge human leftovers (Traeholt, 1993; Traeholt, 1994a, b; Auliya, 2003). Such an adaptive shift in eating habits may aid in the maintenance of populations in areas in which traditional *V. salvator* habitat has begun to overlap with human development. However, the allure of garbage combined with a potential lack of concern regarding humans may also subject such *V. salvator* individuals to an easy capture, leading to heavy harvesting of local populations.

Tinjil Island, located off the southern coast of West Java, Indonesia (Fig. 1), has a *V. salvator* population that has been casually observed for many years, though no scientific work has been done on the island's population (R. Kyes, pers. comm.). Since 1987, Tinjil Island has been designated as a natural habitat breeding facility for long-tailed macaques (*Macaca fascicularis*) (Kyes, 1993), and has had limited accessibility to humans. *Varanus salvator* appears to be the only varanid species living on Tinjil Island. In addition, the island's *V. salvator* population has no known natural predators as in most areas of its range, and has not been subjected to human hunting pressures. As such, Tinjil Island lends itself well to the study of relatively undisturbed *V. salvator* populations that have had potentially regular yet limited contact with humans.

The purpose of this study was to compare relative abundances of monitors in two types of areas. Monitor abundance in areas of human habitation where food leftovers were often available was compared to monitor abundance in areas where human activity was not associated with food to evaluate the effect of human presence on lizard location and behavior. As it has been shown that monitors will scavenge food if available in the form of human leftovers (Auliya, 2003) it was predicted that the concentration of monitors would be higher in areas of human settlements, due to the presence of food

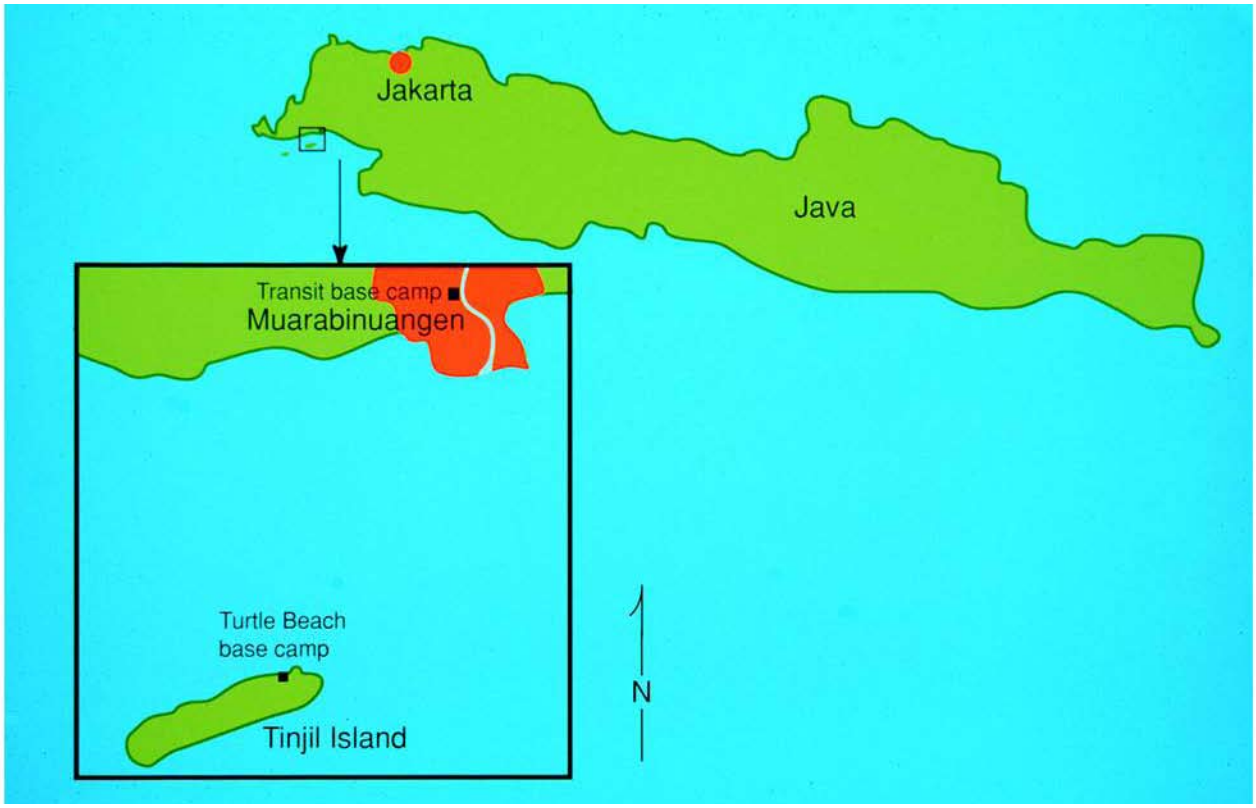

Fig. 1. Location of Tinjil Island off the southern coast of West Java, Indonesia.

or possible association between humans and food in the form of leftovers or garbage.

Methods

The study was conducted on Tinjil Island, located approximately 16 km off the south coast of West Java, Indonesia (Fig. 1). The island consists primarily of lowland, secondary tropical rain forest and coastal vegetation. Tinjil is approximately 1 km wide (north-south), and 6 km long (east-west), with a total area of approximately 600 hectares.

Multiple transects have been cleared on the island to facilitate regular surveys of the island's *M. fascicularis* population; three east-west, and nine north-south (Fig. 2). Turtle Beach base camp, located on the northeast edge of the island, is the largest camp on the island and is the only area where there are permanent facilities. There are no permanent residents on Tinjil Island, though the island is staffed year-round by a few caretakers of who rotate off and on from the mainland of Java. In addition to Base Camp, there are three additional areas that are typically inhabited by local fishermen, spaced along the northern edge of the Island. These three camps are referred to as fisherman camps #1, #2, and #3. The fisherman camps are smaller scale camps with primitive huts and no modern facilities. Fishermen who utilize the camps are typically based on the main land of Java, but use the camps for days at a time when fishing off the coast of Tinjil Island. Cooking and food handling by humans were common occurrences in both Base Camp and the fisherman camp areas throughout the course of the study.

Varanus salvator abundance in areas of human habitation (where food leftovers were present) and uninhabited areas (where there were no human food leftovers) of Tinjil Island were estimated by sampling along both the preexisting line transects and around the base camp and fisherman camps. Sampling took place from 28 August 2008 to 10 September 2008, with observations and data collection done primarily between the morning and early afternoon (ca. 0645-1200 h) every day, rotating between the CD and SA transects, and counts of the fisherman and base camp populations. Transects CD (running the full length of the island east to west) and SA (running the full width of the island north-south) represent locations that were not commonly frequented by people, while base camp (bc) and fisherman camps (fc) #1, #2, and #3 are representative of areas often inhabited by people. Line transect sampling was conducted by walking along the transects at a rate of approximately 2-2.5 km per hour. The distance from transect to monitor lizard was measured for each animal sighted. Fisherman camp counts were taken by conducting a modified point

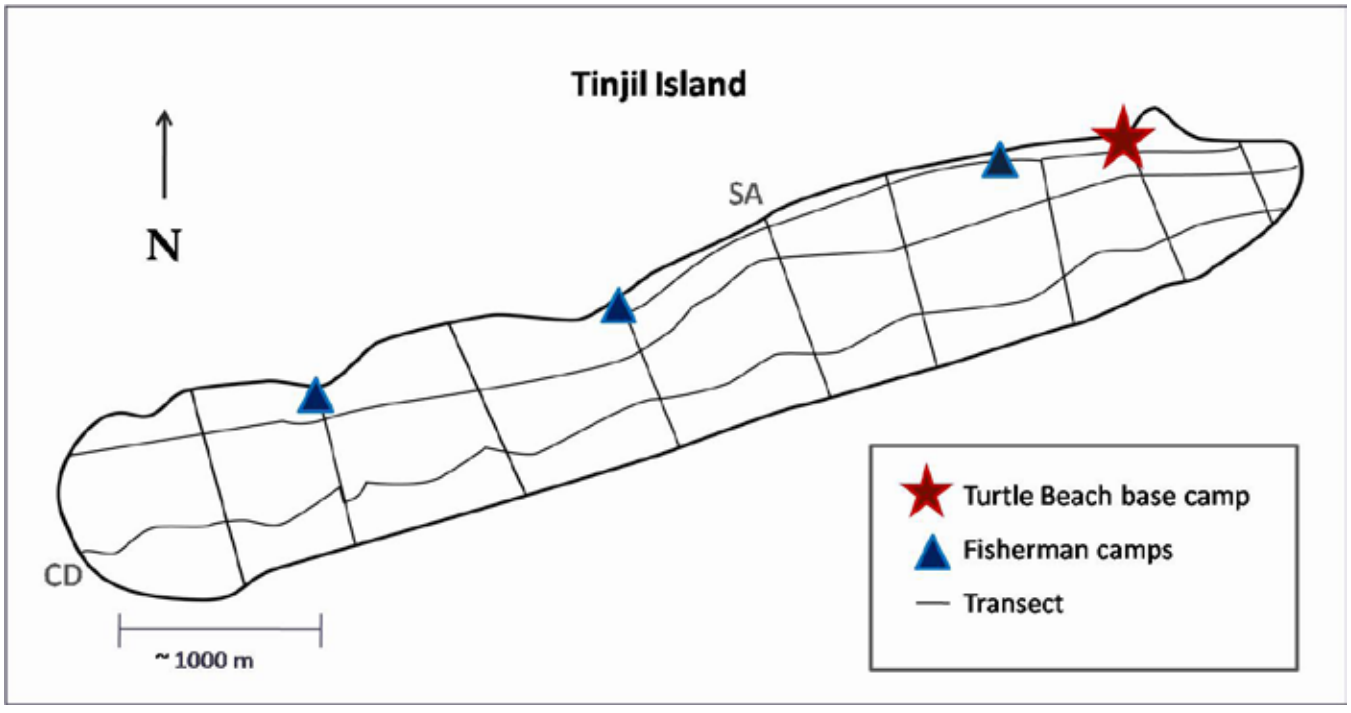

Fig. 2. Tinjil Island transects and location of fisherman camps.

count from the center of each camp. Sampling was accomplished by walking a radius of 5 m from the center of camp (Fig. 3) at a rate of approximately 2-2.5 km per hour. Fisherman camps consisted of 3-5 small huts, were bordered by forest on one side and the ocean on the other, and were clearly delineated sandy areas in which monitor lizards were readily visible.

Time of contact, location on transect (utilizing location markers which are placed every 25 m along the transect), compass direction from the transect and basic behavior of the animal (i.e. moving, basking,) were recorded.

Basic sampling schedule:

Day 1: transect CD
Day 2: point count base camp and fisherman areas #1- #3
Day 3: transect SA
Day 4: observation / rest

Monitor abundance was determined based on a calculation of number of animals seen, divided by the area covered by transect and fisherman camp area counts. Transect sample areas were calculated based on a strip width of 5 m, since sampling was carried out 2.5 m on each side of the transect line. A strip width of 5 m was selected due to the trail itself being 2-3 m in width with the immediate areas on either side of the trail being relatively clear. Total transect area sampled was equal to 5 m multiplied by the length of the transect which in the case of CD was 7 km, and in the case of SA was 1 km. The sampled base camp (bc) area was based on a radius (r) of 20 m, with the sampled area = πr^2. Likewise, the areas of the fisherman camp (fc) counts were based on a radius of 15 m.

Estimated abundance of monitors in uninhabited areas was calculated by combining raw data from all counts of CD and SA transects, while monitor abundance in inhabited areas was estimated by combining counts of base camp and fisherman camps. Poisson distributions were used to compare the two estimates for statistical significance ($p<0.05$).

Results

Raw data on transect and camp sampling are presented in Table 1. Transect CD was sampled 6 times, and SA sampled 5 times to gather information on presence of *V. salvator* in areas of Tinjil Island with low human activity (and no human food leftovers). During the course of these samples, only one individual was observed. The individual was an adult *V. salvator* which was directly on the trail and flushed upon human approach. The base camp was sampled 15 times for a total of 45 sightings, and fisherman camps #1, #2, and #3 were sampled

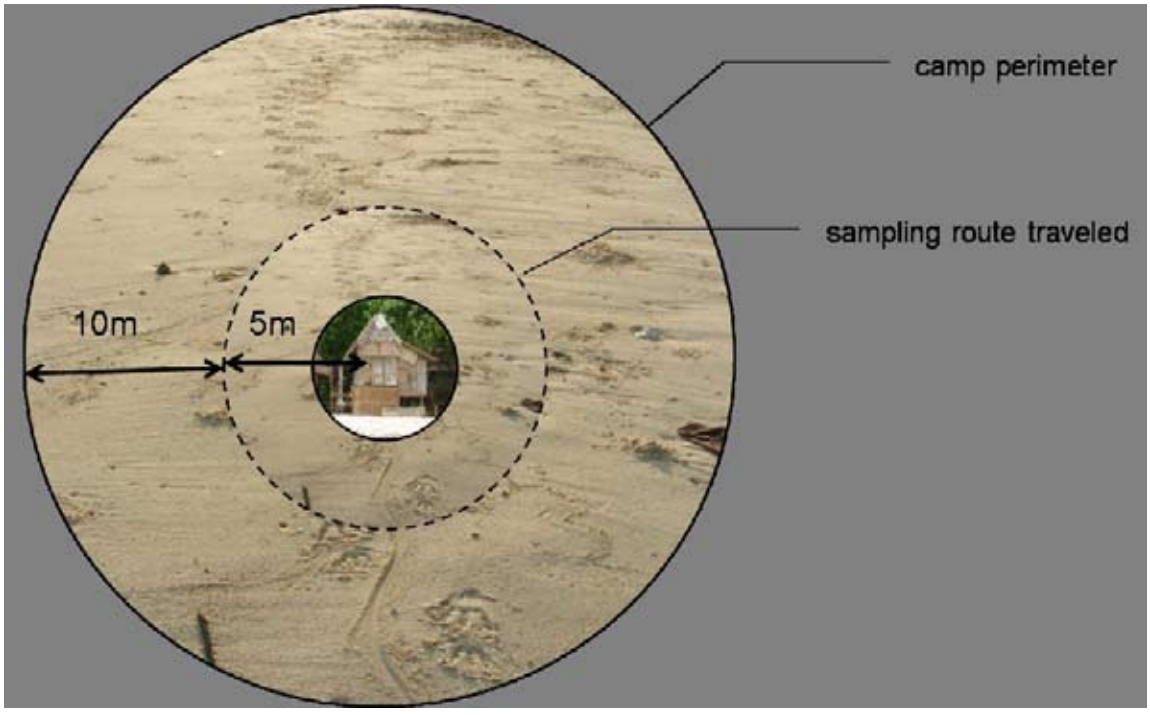

Fig. 3. Sampling area of fisherman camps.

Table 1. Transect and camp sampling.
A=adult, sA=subadult, J=juvenile, tl=total number of sightings
*approximate abundance in specimens/km^2

Sampling Location	Area (km^2)	# of Samples	Total Area Sampled (km^2)	# of Sightings	Abundance
CD	0.0350	6	0.2100	0	0
SA	0.0050	5	0.0250	1A	40
CD+SA			**0.0235**	**1A**	**4**
bc	0.0013	15	0.0190	32A, 8sA, 5J = 45 tl	2400
fc1	0.0007	12	0.0084	1A, 1J = 2 tl	200
fc2	0.0007	10	0.0070	1A, 2sA, 2J = 5tl	700
fc3	0.0007	8	0.0056	1A, 3sA. 1J = 5 tl	900
fc1 + fc2 + fc3			**0.0210**	**12**	**600**
bc + fc1,fc2, fc3			**0.0400**	**57**	**1400**

12, 10, and 8 times respectively for a combined total of 12 sightings. Total length of individuals observed throughout the course of the study ranged from 80 cm to approximately 2 m.

Estimated monitor abundance in uninhabited areas CD and SA combined was calculated at approximately 4 specimens per square kilometer, while an abundance estimate of the fisherman camp areas combined with base camp yielded a statistically significant difference of approximately 1400 animals per square kilometer (Poisson test, $p<0.0001$). Due to the comparatively high concentration of individuals in base camp (2400 specimens/km^2), combined fisherman camp density (nearing 600 specimens/km^2) not including base camp figures was compared to that of uninhabited areas (4 specimens/km^2) and was also shown to be statistically significant. Estimated monitor abundances in each area sampled are shown in Fig. 4.

Discussion

Tinjil Island

It became clear through the course of observation that *V. salvator* individuals were attracted by the potential for leftover food, particularly at the base camp area. At the base camp area a specific garbage dumping area existed in the form of an uncovered large dirt depression. This "garbage hole" was often occupied by individuals during sampling sessions, and many *V. salvator* were casually observed searching the hole for food on different occasions and at other times of the

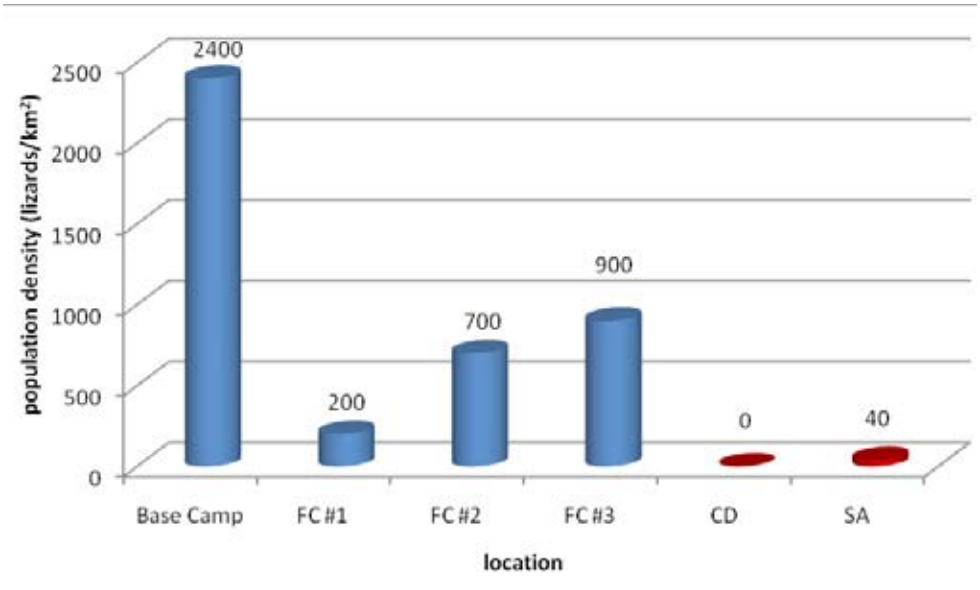

Fig. 4. Estimated relative monitor abundance in camps (blue) and transects (red).

Fig. 5. Subadult *Varanus salvator* at the "garbage hole".

day. Each morning as soon as the sun rose (ca. 0545 h) up to 5 adult *V. salvator* were observed vying for the chance to search or eat at the center of the garbage hole (Fig. 5). Early morning temperatures on Tinjil Island in August and September were relatively warm, averaging around 25°-28° C, and *V. salvator* have been reported to be active at lower average temperatures relative to other monitor species such as *V. komodoensis* (Traeholt, 1995; De Lisle, 2007).

By the time this study was conducted, a daily 0600 h dumping of food scraps at the garbage hole had been established by the base camp cooks. Due to their highly developed sense of olfaction the monitors were attracted to the smell of food once it had been dumped. Interestingly, however, animals were observed searching for food at the garbage hole in the early morning even when the regular schedule of dumping food was halted. This occurred when observation of the religious holiday Ramadan began approximately mid-way through the course of the study. Due to the month-long fasting associated with Ramadan, cooks departed from the usual schedule of food preparation and as a result did not dump food scraps in the early morning as was typical in other times of the year. Despite the change in schedule, monitors continued to arrive at the garbage hole at daybreak. Though on a smaller scale and less regular schedule, fisherman camps also provided potential leftovers for scavenging, as fisherman often gutted or cleaned their fish around camp, as well as frequently cooking over an open fire. Monitors sighted at fisherman camps were sometimes observed in the "investigative search" behavior described by Traeholt (1993), which was characterized by regular tongue flicks combined with lateral head movements and slow forward speed.

Tinjil Island's monitors have likely been conditioned to associate people with food in areas where human leftovers are commonly encountered, and to expect food scraps to be available at certain places and times. Such conditioning could have led to regular visits to the garbage hole in the early morning due to the base camp cooks' daily schedule of food scrap dumping. If such conditioning had in fact occurred, it was also irregularly reinforced by the unscheduled dumping of additional food scraps throughout the day, as well as by the potential for discovering incidental bits of food and garbage left around in other areas of the base camp.

Though scheduled sampling attempts on CD and SA transects yielded only a single sighting, additional monitors were encountered incidentally in other areas of the island and throughout the course of the study, suggesting that an estimate of 4 specimens/ km^2 in uninhabited areas may have been excessively low. While it is possible and even likely that monitor abundance along CD and SA transects is significantly lower than other areas of the island, several factors may have led to counts that are not fully representative of the study population. Juveniles for example, due to intraspecific competition and possible cannibalism around the garbage hole, where the largest adult present aggressively defended the food source, are more likely to be difficult to spot and may be found predominantly in trees, potentially leading to inaccurate counts. Monitors sighted incidentally while walking or while sampling transects were typically spotted when flushed from what were most likely basking or resting positions, and were never observed in the "investigative search" behavior. While monitors in the base camp or fisherman camp areas were often moving and highly visible in open areas, specimens resting or lying inactive in areas not immediate to the transects may have been more likely to remain inactive, and potentially unseen. A 5 m transect strip width used for calculating population density was conservative, as typical behavior of monitors spotted within and beyond this range was a characteristically

noisy and obvious flushing. However, a tendency to lie beneath the leaf litter when resting should also be noted as a behavior which could potentially make less easily frightened monitors difficult to spot when sampling on the transects. It is also possible that in response to human approach, animals on the transects were simply flushing or moving away from the sampling area before researchers were able to detect their presence. It is also important to consider the possibility that multiple factors may have led to excessively high estimations of monitor lizard density in areas of human activity such as the garbage hole. Monitors were not marked or identified individually, and were likely counted numerous times over multiple samplings of these areas as a result. Scaling the original, small effective sample areas to kilometers squared, along with using a total estimate of sightings rather than a mean estimate of sightings at each site also potentially contributed to a likely overestimation of monitor abundance in the base camp and fisherman camp areas. Due to limitations of the study methods, emphasis should be placed on results regarding the relative abundances of animals observed rather than interpreting the estimated values of abundance as an absolute population estimate of Tinjil Island's total monitor lizard numbers.

Tinjil Island's *V. salvator* population has no known predators and is not subjected to harvesting by humans. At 16 kilometers away from the main island of Java, Tinjil's population is essentially isolated. When observed in areas of human habitation, monitors did not appear threatened by humans, did not aggressively approach them, and seemed relatively unconcerned by regular human activity, infrequently fleeing and more often slowly avoiding direct contact. However, when observed in areas uninhabited by humans, monitors seemed more likely to flush abruptly and to frantically flee greater distances.

Reported *V. salvator* home ranges have varied from 15-150 ha depending on population location and source (Gaulke et al., 1999; Auliya, 2003). With a total area of 600 hectares, it is possible that Tinjil Island supports several *V. salvator* populations with different home ranges. If so, monitors with home ranges encompassing areas lacking regular human presence may not be habituated to human activity. As a result, such individuals may react differently upon encountering humans than those who have become accustomed to functioning around human activity. It is also possible that monitors do in fact have large home ranges that overlap inhabited as well as uninhabited areas, but that expectations regarding presence or absence of human activity result in a variety of reactions depending on the location of the monitor-human encounter.

Fig. 6. Adult specimen of *V. salvator* on Tinjil Island..

Implications for future study

This study has shown that monitor lizards will eat human leftovers and are not necessarily deterred by human presence. As human populations continue to grow, the trend will likely continue. It has already been suggested that such a tendency for monitors to be drawn closer to humans may leave financially prized *V. salvator* individuals vulnerable to capture, which could further result in extinction of local populations. In some instances monitors have appeared on average to be larger and more robust in some areas of incidental human supplementation (Auliya, 2003), demonstrating that an adaptation to coexistence with humans could be beneficial to monitor populations. Conversely, on many of the Philippine islands for example, human presence has resulted in water monitor populations retreating to areas with less profitable but natural food resources (Gaulke, 1991).

Sustainability of V. salvator populations

Habitat loss and harvesting due to global demand are both factors which affect monitor lizard population trends. However, accurately assessing the effects of factors such as hunting or deforestation on *V. salvator* populations is an understandably difficult undertaking. Though long term sustainability of *V. salvator* is certainly an issue of concern, current populations are difficult to estimate, and lack of adequate data has led to international agencies' differing interpretations of the severity of the situation. While *V. salvator* has been listed under CITES Appendix II since 1975, it is not correspondingly listed on the current 2008 version of the IUCN Red List. Admittedly, there have not been clear signs of population decline despite periods of intense harvesting of wild populations, leading many to believe that strict regulation may not be necessary. Additionally, many Indonesian communities have an economic reliance on *V. salvator* as a renewable natural resource, which may lead to a reluctance of government agencies to limit the harvesting of a species which is not visibly threatened or decreasing in numbers (Saputra, 1998; Soehartono and Mardiastuti, 2002).

Indonesia has come under international scrutiny due to concerns regarding the sustainability of such a high volume of skin trade, and has responded by reducing domestic export quotas in 1994, and conducting workshops such as the 1996 'Conservation, Trade and Sustainable Use of Lizards and Snakes in Indonesia' (Engler et al., 2007). Despite such measures, Indonesia has suffered from a lack of adequate resources, including insufficient numbers of enforcement officers to monitor the country's 17,000+ islands and vast geographic area. Not only does financial gain serve as a great incentive to illegally harvest high-value monitor lizards such as *V. salvator*, but complex trade routes combined with intricate re-import and re-export schemes of skins during various stages of processing also make any estimation of actual trade numbers extremely difficult. Despite notable CITES pressure from 1994 onward and implementation of further reduced export quotas in 1996, Indonesia has consistently shown an inability to properly regulate its reptile trade, including the trade of both live *V. salvator* specimens and *V. salv*ator skins (Soehartono and Mardiastuti, 2002).

In recent years, efforts to study all aspects of monitor lizard biology and behavior have increased. However, further research is necessary to assess both the immediate and long-term effects of human presence on the *V. salvator* populations, as well as to complete more accurate surveys in providing population baseline data for sustainability assessments. Finally, issues of adequate resources and funding must be addressed if the international expectation for a single threshold country such as Indonesia to successfully regulate the majority of the world's varanid skin exports is to be met.

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References

Auliya, M. 2003. Taxonomy, Life History and Conservation of Giant Reptiles in West Kalimantan (Indonesian Borneo). Münster: Natur und Tier Verlag.

Böhme, W. 2003. Checklist of the living monitor lizards of the world (family Varanidae). Zoologische Verhandelingen 341: 3-43. http///www.cites.org/common/cop/12/ESF12i-06A.pdf. (Last accessed 30/10/08)

De Lisle, H.F. 1996. Natural History of Monitor Lizards. Krieger Publishing Company, Malabar, Florida.

De Lisle, H.F. 2007. Observations on *Varanus s. salvator* in North Sulawesi. Biawak 1(2): 59-66.

Engler, M and R. Parry-Jones. 2007. Opportunity or Threat: The Role of the European Union in Global Wildlife Trade. Brussels, Belgium: TRAFFIC Europe.

Gaulke, M. 1991. On the Diet of the Water Monitor, *Varanus salvator*, in the Philippines. Pp. 143-153 in Böhme, W. and H.-G. Horn (eds,). Advances in Monitor Research. Mertensiella 2.

Gaulke, M., W. Erdelen and F. Abel. 1999. A Radio-Telemetric Study of the Water Monitor Lizard (*Varanus salvator*) in North Sumatra, Indonesia. Pp. 63-78 in Horn, H.-G. and W. Böhme (eds.). Advances in Monitor Research II. Mertensiella 11.

Green, B. and D. King. 1993. Goanna. The Biology of Varanid Lizards. Sydney, NSW: NSW Univ. Press.

Horn, H. 1999. Evolutionary Efficiency and Success in Monitors: A Survey on Behavior and Behavioral Strategies and some Comments. Pp. 167-180 in Horn, H.-G. and W. Böhme (eds.). Advances in Monitor Research II. Mertensiella 11.

Iskandar, D. T. and W. R. Erdelen. 2006. Conservation of amphibians and reptiles in Indonesia: issues and problems. Amphibian and Reptile Conservation 4(1): 60-87.

Jenkins, M. and S. Broad. 1994. International Trade in Reptile Skins: A Review and Analysis of the Main Consumer Markets. 1983-91. Cambridge, U.K.: TRAFFIC International.

Koch, A., M. Auliya, A. Schmitz, U. Kuch and W. Böhme. 2007. Morphological studies on the systematics of south east Asian water monitors (*Varanus salvator* Complex): nominotypic populations and taxonomic overview. Pp. 109-180 in Horn, H.-G., W. Bohme and U. Krebs (eds.). Advances in Monitor Research III. Mertensiella 16, Rheinbach.

Kyes, R.C. 1993. Survey of the Long-Tailed Macaques introduced onto Tinjil Island, Indonesia. American Journal of Primatology 31: 77-83.

Luxemoore, R. and B. Groombridge. 1990. Asian Monitor Lizards. A Review of Distribution, Status, Exploitation, and Trade in four selected Species. Report to the CITES Secretariat, World Conservation Monitoring Centre, Cambridge.

Saputra, G. 1998. IRATA's Role in Conservation and Sustainable Use of Reptiles. Mertensiella 9: 23-25.

Shine, R., Harlow, P.S., and J.S. Keogh. 1996. Commercial Harvesting of Giant Lizards: The Biology of Water Monitors *Varanus salvator* in Southern Sumatra. Biological Conservation 77: 125-134.

Sodhi, N.S., Koh, L.P., Brook, B.W., and P.K.L. Ng. 2004. Southeast Asian Biodiversity: an Impending Disaster. Trends in Ecology and Evolution 19(12): 654-660.

Soehartono, T. and Mardiastuti, A. 2002. CITES Implementation in Indonesia. Nagao Natural Environment Foundation. Jakarta, Indonesia.

Traeholt, C. 1993. Notes of the Feeding Behavior of the Water Monitor, *Varanus salvator*. Malayan Nature Journal 46: 229-241.

Traeholt, C. 1994a. The Food and Feeding Behaviour of the Water Monitor, *Varanus salvator*, in Malaysia. Malayan Nature Journal 47: 331-343.

Traeholt, C. 1994b. Notes on the Water Monitor *Varanus salvator* as a Scavenger. Malayan Nature Journal 47: 345-353.

Traeholt, C. 1995. A Radio-Telemetric Study of the Thermoregulation of Free Living Water Monitor Lizards, *Varanus s. salvator*. Journal of Comparative Physiology B 165: 125-131.

TRAFFIC and the IUCN/SSC Wildlife Trade Programme. 2004. Taxa Identified as possible Candidates for inclusion in the Review of significant Trade in Specimens of Appendix–II Species. Twentieth Meeting of the CITES Animals Committee Johannesburg (South Africa), 29 March - 2 April 2004.

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Stomach Content Note for a Road-killed *Varanus spenceri*

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Abstract - There is a significant lack of dietary records available in literature for wild *Varanus spenceri*. When a wild specimen had been killed by a motor vehicle, the opportunity to examine the specimens stomach contents was taken. The single item found in the stomach contents of the adult *V. spenceri* was the tail of a *Pogona henrylawsoni*; a previously unrecorded prey item.

Introduction

Varanus spenceri is one of Australia's larger monitor species, measuring up to 1.35 m in total length (Lemm and Bedford, 2004). A stocky, ground-dwelling monitor, *V. spenceri* occurs in Black Soil Plains and Mitchell Grass Plains habitats. These habitats are often treeless and in many places offer little vegetation other than Mitchell grass (*Astrebla sp.*). The black clay soil on which these monitors occur develops large cracks and crevices in the ground which can be up to 1.5 m deep (Lemm and Bedford, 2004). These cracks can be patchy in distribution throughout the lizard's range and while cracks may remain in some areas annually, seasonal wet and dry weather conditions, which often include floods, can alter the cracks. *Varanus spenceri* utilizes these cracks for refuge and thermoregulation. Despite the fact that this large species of monitor occurs along at least two major routes through Queensland and the Northern Territory (Cogger, 1994), there are limited published field observations, most of which are based on natural history. Few records of documented prey items exist for *V. spenceri*. Documented dietary items include mammals (primarily *Rattus villosisimus*), elapid snakes, agamids and insects (primarily beetles and locusts) (Stammer, 1970; Pengilley, 1981; Valentic, 1997). Although agamid lizards have been documented in the diet of *V. spenceri*, a positive identification of one agamid species consumed by *V. spenceri* is documented here.

Observation

On 13 October 2008 at 0930 h along the Landsborough Hwy., 110 km south of Winton, Queensland, a road-killed *V. spenceri* was found on the paved highway. It is estimated to have been deceased for approximately one to two hours. This monitor lizard had been struck on the head by a motor vehicle and there was no apparent external damage to the trunk of the specimen. The specimen measured 460 mm SVL and 890 mm in total length; however, a fresh portion of the tail tip was missing, presumably due to the collision with the motor vehicle. Internal examination revealed the specimen to be male by the presence of testes and lack of a female reproductive tract. Inside the stomach was a tail belonging to a *Pogona henrylawsoni* (Figs. 2 and 3).

Fig. 1. Road-killed adult male *Varanus spenceri* photographed after being moved off the bitumen road. Pattern is typical for the locality and this form seems to be predominately in the eastern part of their range as opposed to specimens with the broad bands on the neck and back from further west.

Fig. 2. *Pogona henrylawsoni* tail removed from stomach.

Fig. 3. Closer view of removed *P. henrylawsoni* tail.

The tail is distinguished as that of a *P. henrylawsoni* as opposed to *P. viticeps* by the presence of enlarged spines at the base of the tail. The tail of *P. henrylawsoni* tapers off close to the base of the tail whereas in *P. viticeps,* the tail narrows consistently to the tip. *Pogona henrylawsoni* is the more common species at this locality; we have yet to establish whether *P. viticeps* occurs in the vicinity of this observation.

Discussion

It was difficult to ascertain whether the entire *P. henrylawsoni* had been consumed and not completely digested, or whether only the tail had been consumed of either a live or road-killed *P. henrylawsoni*. It is likely that *V. spenceri* would prey upon live adult *P. henrylawsoni*. The relationship in size would further suggest that *P. henrylawsoni* would be a manageable meal for a large *V. spenceri*. *Varanus spenceri* occurs throughout most of the range of *P. henrylawsoni* and on the morning of this record, three live specimens of *P. henrylawsoni* were seen within 1 km of the dead monitor and approximately ten other live *P. henrylawsoni* were seen that morning, suggesting that they are common in this part of *V. spenceri* range. This record is evidence that if nothing else *V. spenceri* will scavenge on dead *P. henrylawsoni,* but it is likely that this is a case of predation.

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References

Cogger, H. 1994. Reptiles and Amphibians of Australia. Cornell University Press, Ithaca, New York. 778 pp.

Lemm, J. and G. S. Bedford. 2004. *Varanus spenceri* pp. 466-471 In*:* Varanoid Lizards of the World. Pianka, E. R. and D. R. King (ed). Indiana University Press, Bloomington, IN. 587 pp.

Pengilley, R. 1981. Notes on the biology of *Varanus spenceri* and *V. gouldii*, Barkly Tablelands, Northern Territory. Australian Journal of Herpetology 1(1): 23-26.

Stammer, D. 1970. Goannas. Wildlife Australia 7: 118-120.

Valentic, R.A. 1997. Diet and reproduction status on a roadkill Spencer's Monitor, *Varanus spenceri*. Herpetofauna 27(2): 43-45.

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A Road-killed Water Monitor *Varanus salvator macromaculatus*: Negative Impact from the Forest Route in Khao Yai National Park, Thailand

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Abstract – A juvenile water monitor *Varanus salvator macromaculatus* was killed by a car in Khao Yai National Park, Thailand. Recently, this national park has seen a rapid increase in tourism and vehicles recorded monthly. Our result suggests that the National Park should set time restrictions for vehicle traffic, especially during 1800-2000 h since the highest rates of road mortality occur during this time.

At 1630 h on 15 October 2002, the carcass of a juvenile water monitor *Varanus salvator macromaculatus* (ca. 100 cm in total length; see Fig. 1) was presented to the author (PD) by Amnuoy Intharat, director of Khao Yai Forestry Training Center. The monitor was killed by a car on the forest route in Khao Yai National Park, Nakhon Ratchasima Province, at 14°24'41"N; 101°22'20"E, and ca. 800 m in elevation (Fig. 2). Later, a necropsy was performed by an officer of the Khao Yai Forestry Training Center to ascertain its stomach contents. Its stomach did not contain any prey items; however, unknown endoparasites (appearing to be tapeworms) were found in the esophagus, stomach and small intestine. Unfortunately, the *Varanus salvator macromaculatus* specimen and its endoparasites were burned immediately after the necropsy, preventing proper parasite identification.

Fig. 1. A road-killed juvenile *Varanus salvator* at Khao Yai National Park, Thailand. Photograph by Prateep Duengkae on 15 October 2002.

The first national park in Thailand, Khao Yai National Park, was established in 1961 with an area of 2,168 km^2 covering four provincial areas of Nakhon Nayok, Nakhon Ratchasima, Prachin Buri and Sara Buri. Together with Tap Lan National Park, Pang Sida National Park and Ta Phraya Wildlife Sanctuary, these national parks were promoted as the World Heritage site in 2005 and were named the "Dong Phayayen – Khao Yai Forest Complex" (DPKY-FC). Biodiversity of flora and fauna in Khao Yai National Park was reported at over 2,000 species of plants (Puff, 2006), 72 species of mammals (including 18 endangered species), 300 species of birds (National Park Wildlife and Plant Conservation

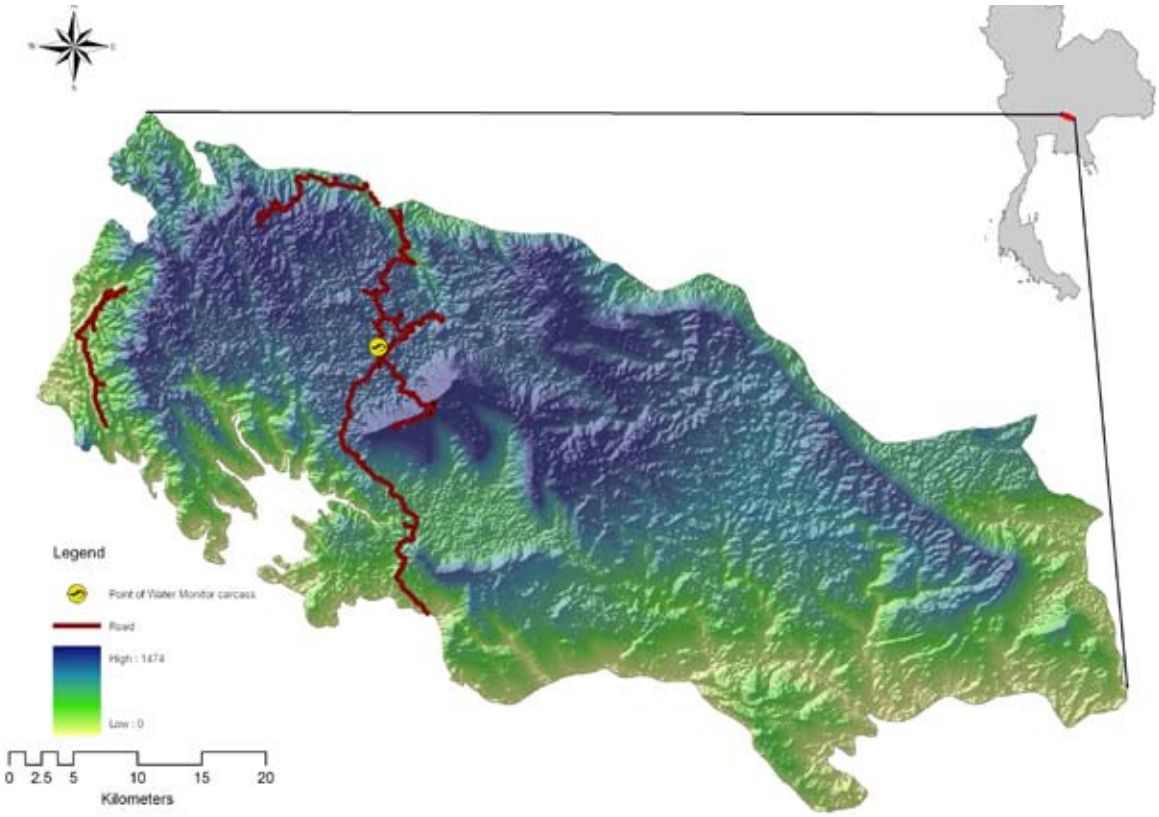

Fig. 2. Map of Khao Yai National Park with forest route.

Department, 2004) and 70 species of amphibians and reptiles (Prapun, 1999).

Approximately 50 km of forest roadways were constructed running north to south in Khao Yai National Park. Traveling by car, Khao Yai is only two hours from Bangkok; therefore, the park is a popular destination for spending long holidays or weekends. In the last decade, ca. 800,000 visitors were annually recorded for this park (National Park Wildlife and Plants Conservation Department, 2005). Recently, there has been a rapid increase in tourism, with over 20,000 vehicles recorded monthly in 2007-2008 (National Park Wildlife and Plant Conservation Department, 2008). The negative impact from the use of vehicles on the forest route directly affects the mortality of wildlife in this park as also reported for other areas (e.g., Kunuri, 2004). Unfortunately, records of this impact in Thailand are rare (Wanghongsa and Boonkird, 2001), especially in Khao Yai National Park as shown in our report. Additionally, in 2002 a snake (Family: Colubridae) and civet (Family: Viverridae) were reported as victims of road mortality in Khao Yai National Park (Amnuoy Intharat, pers. comm.). Their one year old carcasses were exhumed and are presented in Figs. 3 and 4.

Construction of roads and the use of vehicles directly affect the habitat of animals (Trombulak and Frissel, 1992). Roads fragment habitats and numerous animals are killed by vehicles while migrating and crossing over roads (Coelho et al., 2008). Resolving the negative impacts of road construction and the use of vehicles in Khao Yai National Park should involve greater consideration of the biology and ecology of local wildlife, to determine the best approach to prevent,

Fig. 3. An exhumed one year old carcass of a snake (Family Colubridae) killed on the road at Khao Yai National Park, Thailand. Photograph by Prateep Duengkae on 15 October 2002.

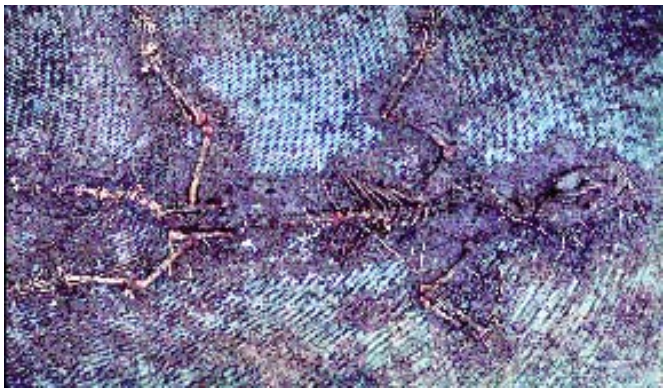

Fig. 4. An exhumed one year old carcass of a civet (Family Viverridae) that was killed on the road at Khao Yai National Park, Thailand. Photograph by Prateep Duengkae on 15 October 2002.

resolve, or reduce such negative impacts**.** We would like to suggest that the National Park should set time restrictions for vehicle traffic, especially during 1800-2000 h since the highest rates of road mortality occur during this time (Wanghongsa et al., 2007). Moreover, building more speed bumps on the route to slow down vehicular traffic in Khao Yai National Park should be considered.

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References

Ferreras P, J. J. Aldama, J. F. Beltran and M. Delibes. 1992. Rates and causes of mortality in a fragmented population of Iberian lynx *Felis pardini* Temminck, 1824. Biological Conservation 61: 197–202.

Coelho, I. P., A. Kindel and A. V. P. Coelho. 2008. Roadkills of vertebrate species on two highways through the Atlantic Forest Biosphere Reserve, southern Brazil. European Journal of Wildlife Research 54: 689–699.

Kunuri, K. 2004. Impacts of Wildlife Feeding in Khao Yai National Park: Case Study of Pig-tailed Macaque (*Macaca nemestrina*). Unpublished M.S Thesis, Kasetsart University, Bangkok. (in Thai)

National Park, Wildlife and Plants Conservation Department. 2004. Dong Phayayen – Khao Yai Forest Complex World Heritage Nomination. Bangkok.

___. 2005. Statistical data National Park Wildlife and Plant Conservation. Bangkok.

___. 2008. Tourist Statistic. http://www.dnp.go.th/NPRD/develop/Stat_Tourist.php (Last accessed 13.11.08)

Prapun, S. 1999. The survey of Sambar deer (*Cervus unicolor*) in grassland of Khao Yai national park. Royal Forest Department, Bangkok.

Puff, C. 2006. Plants of Khao Yai National Park. National Park, Wildlife and Plant Conservation Department, Bangkok.

Trombulak, S. C. and C. A. Frissell. 1992. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14: 18-30.

Wanghongsa, S., and K. Boonkird. 2001. Road-killed vertebrates in Khao Ang Rue Nai Wildlife Sanctuary. Wildlife Yearbook 3: 100-117. Royal Forest Deparment, Bangkok.

Wanghongsa, S., Y. Senadham and K. Boonkird. 2007. From large massacre in the heart of jungle to the time allocation for the welfare of wildlife. Wildlife Yearbook 8: 269-280. National Park, Wildlife and Plant Conservation Department, Bangkok.

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Hemipenal Transillumination as a Sexing Technique in Varanids

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Abstract - A technique for assisting in the determination of gender in varanids of various ages is described. The technique, termed hemipenal transillumination technique or HTI technique, is based around the candling of the tail base using a bright light. The basic technique, technique variations and expected results are described.

Introduction

In 2007, Davis and Leavitt adapted a means of checking for gravidity in the very small xantusiid species *Xantusia vigilis* as a means of sexing these very small skinks. I have adopted this technique (which I have called the hemipenal transillumination technique or HTI technique) and have subsequently utilised it for sexing over 60 species of Australian lizards including agamids, gekkonids, varanids and scincids of various ages. The technique can be used on both juveniles and adults and does not require that the individuals are sexually mature before the characteristics are visible. Like any technique, practice makes perfect and regular examination of individuals of known gender can allow you to develop a "feel" for what to expect.

Technique

The animal is positioned on its back so that the tail is directed towards the handler. A small, focused, very bright (but non-heat producing) light source is positioned behind the dorsal side of the tail to direct a beam of light through the tail base. I have found that visualization is improved if the light beam is directed only behind the tail, where stray light around the edges of the tail is limited. This light allows the internal anatomy of the tail base to be visualized. In male lizards, the hemipenes are visualized both by their increased blood supply compared to adjacent tissue and the increased density of tissue in this area. They will be seen as either red dots, red ovals or as a "dull redness" (Figs. 1 and 2). The latter refers to an overall red glow in the tail base. This is caused by a combination of an increase in blood supply and tissue density in the tail base (dorso-ventral thickening to accommodate the hemipenes) and degrees of "shadowing" (limiting light penetration) and "luminance" (as the light penetrates the hemipene and shines through what essentially becomes a red light filter) that creates an appearance of an overall red glow. In a female, an absence of red structures and a general yellowish glow is observed (as the light is only penetrating pure tail tissue) (Figs. 3. and 4). In some adults, the appearance will vary with mood, body temperature and breeding season depending on factors such as seasonal hemipenal size, voluntary extrusion of hemipenes, tail position and hemipenal blood supply changes (often one will appear more "engorged" than the other).

The primary limitations of this technique are light intensity and tissue penetration of light. These two go hand in hand to some degree in that specimens with a dorso-ventral tail diameter of 8-10 mm or smaller are the most ideal candidates for this technique. Specific features such as heavy dorsal pigmentation, heavy dorsal scalation, tail thickness > 8-10 mm and handling difficulties may also limit this technique although technique modifications such as side-on viewing, can be used to work around this. The "side-on" technique involves placing the light source against the side of the tail. In those species where this technique is warranted due to dorsal visualization issues, males exhibit the "dull redness" as described above whilst females exhibit a clean yellow glow. In species with laterally compressed tails and tail bases, such as *V. mitchelli*, side-on viewing through this narrower area of tissue may allow hemipenes to be observed in the same detail as if the light was dorsally directed, as in other species.

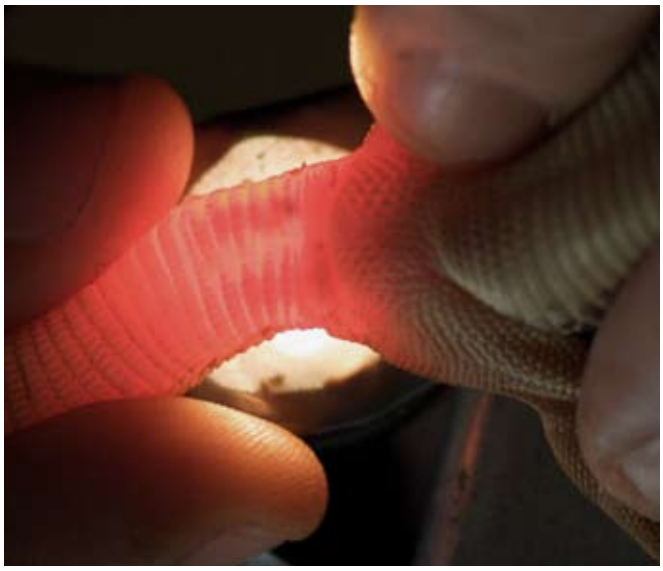

Fig. 1. HTI technique in an adult male *V. storri ocreatus* showing two hemipenes

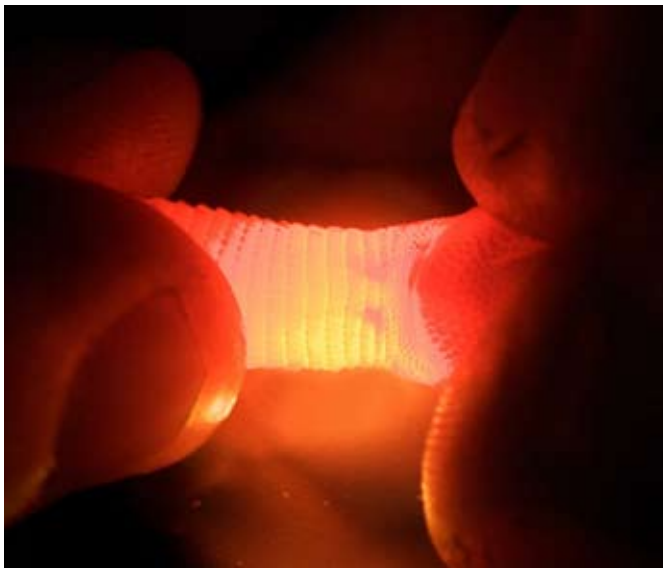

Fig. 2. HTI technique in a juvenile male *V. storri ocreatus* showing hemipenes visible as red "dots"

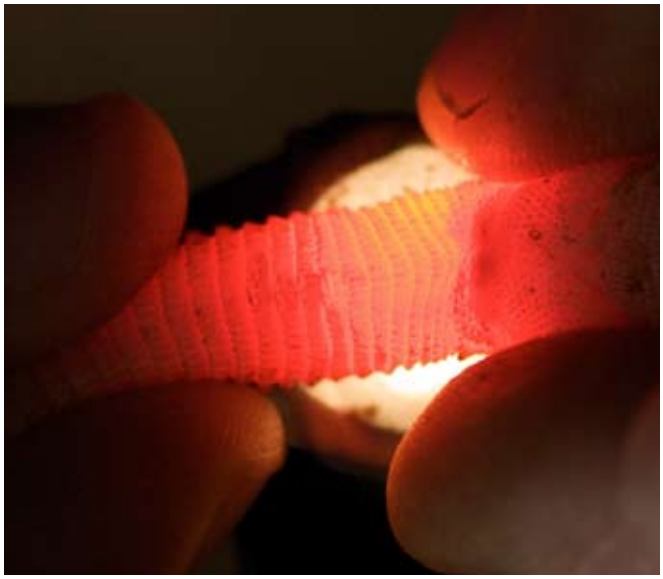

Fig. 3. HTI techniques in an adult female *V. storri ocreatus* showing clear yellow glow and absence of additional structures

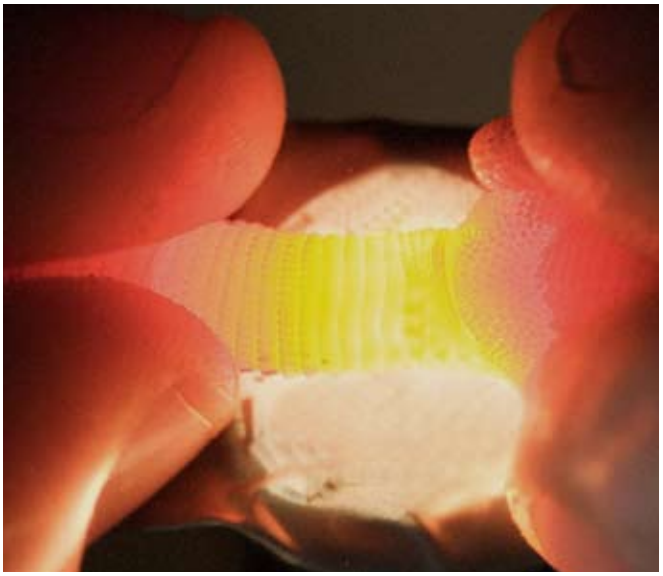

Fig. 4. HTI technique in a juvenile female *V. storri ocreatus* showing no visible hemipenes

I maintain two light types, an incandescent or halogen bulb producing a yellowish light and an LED torch producing bright white light. In some species, tail density is too thin for the use of an LED light as the light "blasts straight through" whereas an incandescent bulb produces a less harsh light that enhances the hemipenes more appropriately. In larger or spiny species, an incandescent bulb may be too subtle and a LED light is required to "blast past" the impediments to visualization. The reduction of light scatter around the edges of the tail can also improve visualization. This may be easily overcome using thick tape over the lens with a viewing hole cut centrally, or by placing a cap over the end (plastic chair leg rubbers are ideal) with a viewing hole cut centrally. Oval-shaped viewing holes are preferred over round ones. Technically, a purpose-built sexing table or box can also be built and may allow a much larger light to be used (or alternatively a dimmable electric globe). It is important to be very careful with excessively intense light sources as these may also produce significant heat and may cause heat damage or thermal burns to the tail if the animal is left in position for an excessive period. The

Table 1. Checklist of species trialed whose gender was confirmed using the HTI technique as well as secondary techniques.

	HTI Technique		Gender Confirmed With Other Techniques			
Species	Adult	Juvenile	X-ray	Popping/Eversion	Secondary Characteristics	Breeding
Varanus acanthurus	√	√	√	√	√	√
V. brevicauda	√	√	√			√
V. bushi	√	√	√		√	
V. caudolineatus	√	n/a	√	√		
V. eremius	√	n/a			√	
V. gilleni	√	√	√		√	√
V. glauerti	√	√		√	√	
V. mitchelli	√	n/a	√		√	√
V. primordius	√	√		√	√	
V. scalaris	√	n/a	√	√	√	√
V. spenceri	n/a	√		√		
V. storri storri	√	n/a	√	√	√	√
V. storri ocreatus	√	√	√	√	√	
V. tristis tristis	√	n/a	√	√	√	√
V. tristis orientalis	√	√			√	

darker the room that the technique is used in, the better the visualization. In the field, I have used this technique inside a dark backpack with good results.

Discussion

In summary, using this technique in monitors has produced the following results (see also Table 1):

- Small arboreal species (e.g., *V. bushi, V. gilleni, V. caudolineatus*) are very easy to sex.
- Small terrestrial species (e.g. *V. storri, V. brevicauda, V. primordius*) are quite easy up to 10 mm in tail thickness.
- Juveniles of many smaller species are sexable from 5 cm SVL.
- Juveniles of larger species such as *V. varius*, *V. gouldii*, *V. giganteus* and *V. panoptes* may be sexed as long as tail thickness is < 10 mm, however only a single larger species, a 3 month old *V. spenceri* was tested. In this specimen, hemipenes were clearly visible.
- Some species may partly evert hemipenes when handled (e.g., *V. primordius and V. brevicauda*), making them difficult to visualize in this state. The hemipenes are essentially tucked up under the cloacal rim but not visible externally. This can be overcome by sexing whilst cooled at room temperature or by placing light pressure at the hemipenal base with a finger to stop the hemipenes from being extruded.
- Hemipenes will appear as long red ovals except if partly extruded, where they will then be seen as red dots very close to the cloacal edge.
- Larger species with a tail thickness of > 10 cm can be sexed “side-on”, with males appearing as a “dull redness” rather than a clear yellow glow.

I would welcome feedback from anybody with regards to the use of this technique in species that I did not have access to for trials, particularly *V. prasinus, V. glauerti, V. kingorum and V. pilbarensis,* as well as larger species such as *V. varius*, *V. gouldii and V. giganteus* as well as non-Australian species.

References

Davis, A.R. and Leavitt, D. H., 2007. Candlelight *vigilis*: A noninvasive method for sexing small, sexually monomorphic lizards. Herpetological Review 38(4): 402-404.

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RECENT PUBLICATIONS

2008

Conrad, J.L., O. Rieppel and L. Grande. 2008. Re-assessment of varanid evolution based on new data from *Saniwa ensidens* Leidy, 1870 (Squamata, Reptilia). American Museum Novitates 3630(1): 1-15.

D'Amore, D. 2008. Komodo monitor (*Varanus komodoensis*) tooth marks on bone and implications for mesozoic ziphodont archosaur behavioral taphonomy. Journal of Vertebrate Paleontology 28(3) supplement: 64A-68A.

Gramentz, D. 2008. Einige Bemerkungen zur Okologie und zum Verhalten von *Varanus salvator* (Laurenti, 1768) im Sudwesten von Sri Lanka. Sauria 30(3): 13-20.

Ilgaz, C., Y. Kumlutas, A. Avci, I. Baran and A. Özdemir. 2008. The morphology and distribution of *Varanus griseus* (Daudin, 1803) (Reptilia: Sauria: Varanidae) in southeastern Anatolia. Russian Journal of Herpetology 15(3): 173-178.

McCue, M.D. 2008. Fatty acid analyses may provide insight into the progression of starvation among squamate reptiles. Comparative Biochemistry and Physiology A-Molecular and Integrative Physiology 151(2): 239-246.

McCue, M.D. and E.D. Pollock. 2008. Stable isotopes may provide evidence for starvation in reptiles. Rapid Communications in Mass Spectrometry 22(15): 2307-2314.

Moldovan, D. 2008. Haltung und Zucht von *Varanus* (*Euprepiosaurus*) *macraei* Böhme & Jacobs, 2002. Sauria. 30(4): 5-10.

Pino-Olivares, A. 2008. *Varanus giganteus* skull mechanical behavior reveals a close resemblance to ceratosaurid dinosaurs. Journal of Vertebrate Paleontology 28(3) Supplement: 127A.

Russell, A. P. & Bauer, A. M. (2008). The Appendicular Locomotor Apparatus of *Sphenodon* and Normal-limbed Squamates. Pp. 1-465. In: C. Gans, A. S. Gaunt & K. Adler (Eds.) Biology of the Reptilia. Vol. 21, Society for the Study of Amphibians and Reptiles, New York.

Tehrani, H., R. Tejero-Trujeque and S.K. Dhital. 2008. Re: Septic arthritis due to a savannah monitor lizard bite: a case report. Journal of Hand Surgery 33(6): 810.

2009

Swan, M. 2009. Keeping and Breeding Australian Lizards. Mike Swan Herp Books. Lilydale. 618 pp.

Doody, J.S., B. Green, D. Rhind, C.M. Castellano, R. Sims and T. Robinson. 2009. Population-level declines in Australian predators caused by an invasive species. Animal Conservation 12(1): 46-53.

Head, J.J., P.M. Barrett and E.J. Rayfield. 2009. Neurocranial osteology and systematic relationships of *Varanus* (*Megalanai*) *prisca* Owen, 1859 (Squamata: Varanidae). Zoological Journal of the Linnean Society 155(2): 445-457.

Lloyd, R., R.A. Alford and L. Schwarzkopf. 2009. Chemical discrimination among predators by lizards: responses of three skink species to the odors of high and low-threat varanid predators. Austral Ecology 34(1): 50-54.

Metcalfe, D.C. and J. Richards. 2009. *Varanus varius* (Lace monitor) Predation. Herpetological Review 40(1): 92-93.