BIAWAK

Quarterly Journal of Varanid Biology and Husbandry

Volume 4 Number 2

ISSN: 1936-296X

On the Cover: *Varanus obor*

Varanus obor is the most recent species of monitor lizard to be described from Indonesia. Discovered by Weijola and Sweet (2010. A new melanistic species of monitor [Reptilia: Squamata: Varanidae] from Sanana Island, Indonesia. Zootaxa 2434: 17-32.), *V. obor* also represents the most recently described member of the *V. indicus* complex. Data and observations on its natural history and ecology are included within the species description.

The specimens depicted on the cover and inset of this issue were photographed by **Valter Weijola** on Sanana Island, Maluku, Indonesia on 28 March and 3 April 2009. The specimen depicted on the cover and to the left was observed around 1600 h in a coastal Sago area of northeastern Sanana. The specimen depicted below was first observed foraging in coastal vegetation, but ascended a coconut palm when it noticed the observer.

BIAWAK

Quarterly Journal of Varanid Biology and Husbandry

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.

ISSN 1936-296X

BIAWAK

Quarterly Journal of Varanid Biology and Husbandry

Volume 4 Number 2
June 2010

Varanus bengalensis bengalensis and *Python molurus molurus*. Vilpattu National Park, Sri Lanka. August 2006. Photograph by **Naalin Perera**.

Monitor Disrupts Court Proceedings

A large monitor lizard ("the type found in water"- presumably *Varanus niloticus*) caused a panic when it appeared in a Zimbabwe courtroom at the trial of four men accused of smuggling generators. The animal was discovered hiding in the witness box prior to the start of the trial. After court personnel and spectators fled, locals chased the lizard out and attempted to kill it before it fled. The trial was postponed and the defendants denied any connection to the monitor's appearance.

Source: New Zimbabwe, 29 April 2010

Audubon Zoo Displays Komodo Dragon

The Audubon Zoo in New Orleans has added a Komodo dragon (*Varanus komodoensis*) to its collection; an 18 year-old male nicknamed "Stumpy" due to its missing much of its tail from when as a hatchling it was bitten off by a sibling. "Stumpy" was hatched in 1992 at the National Zoo making him among the first dragons to be produced in captivity outside of Indonesia.

Source: Zoo and Aquarium Visitor, 26 April 2010

Multiple New Varanids Discovered

Since the beginning of April, five new varanid taxa have been described representing four species and a subspecies. The first of these, *Varanus bitatawa*, is the third frugivorous monitor to be described from the Philippines. Photographs of this animal had been known as early as 2001 and four years later the first specimen was collected. *Varanus bitatawa* is known only from the Sierra Madre Mountains of northern Luzon. Like the related frugivorous monitor species, it is believed to be critically endangered. Also in April, *V. obor* – the first melanistic member of the *V. indicus* species-complex to be named – was described from Sanana in the Sula Archipelago. The species was described from a specimen collected during the mid 19th Century as well as from field observations. Although *obor* occurs widely on Sanana, its limited distribution leaves it vulnerable to various threats such as habitat destruction and collecting pressure. In May, a revision of Philippine water monitors (*V. salvator* species-complex) produced three new forms. *Varanus palawanensis* and *V. rasmusseni* represent melanistic species separated from what were formerly considered populations of *V. marmoratus*; *V. palawanensis* from a disjunct distribution including Greater Palawan and Sibutu in the Sulu Archipelago and *V. rasmusseni* from Tawi-Tawi in the Sulu Archipelago.

Varanus bengalensis bengalensis feeding on millipede. Sinharaja, Sri Lanka. 27 January 2009. Photograph by **Gehan de Silva Wijeyeratne**

Both species are believed to have more extensive distributions than is known. In addition, the dark phenotype of *V. cumingi* from Samar, Leyte, and Bohol was reclassified as a distinct subspecies: *V. cumingi samarensis*. Other aspects of Philippine water monitor taxonomy remain to be resolved including the identity of *marmoratus*-type monitors found on Mindoro.

Sources: Biology Letters doi:10.1098/rsbl.2010.0119 (bitatawa); Zootaxa 2434: 1-54 (obor); Zootaxa 2446: 1-54 (Philippine water monitors)

Worker Attacked by Komodo Dragon

An Indonesian worker on the island of Rinca was attacked and bitten by a two meter Komodo dragon (*Varanus komodoensis*) as he was laboring inside a bungalow. The dragon ceased the attacked after the man hit the animal in the jaws several times. He was taken to a clinic on Bali for treatment of lacerations and a puncture wound.

Source: The Associated Press, 24 May 2010

Report from the Second Annual Meeting of the AG Warane

As in the previous year, the second annual meeting of the AG Warane of the DGHT took place on 24 April 2010 in Hanau near Frankfurt. The thirty-five participants of the meeting represented zoos, private keepers, and scientists. Although the location and program had been finalized well in advance, the program was altered at the last minute because Ursula Bauer (Berlin), executive secretary of Aktion Tier e.V. (a German animal welfare organization), was invited to the meeting on the initiative of Frank Mohr (Würzburg, http://forum.waranwelt.de) due to some recent cases of inappropriate handling and keeping of reptiles (e.g., the case of an escaped cobra in Mühlheim). Subsequently, Aktion Tier had begun a campaign against the keeping of dangerous and exotic animals in captivity (see http://www.aktiontier.org/index.php?m=22&id=684&sub=722) which prompted a public discussion on the topic. Silvia Macina (Hamburg), executive secretary of the DGHT, also arrived for the discussion in order to facilitate an exchange of thoughts and views between animal keepers and animal rights activists. Because of this new item on the agenda, the afternoon talks were pushed back, and time for a debate was included after the lunch break.

Juvenile *Varanus niloticus*. Ruaha National Park, Tanzania. Photograph by **Marcel van Driel**.

The program began with a joint talk by Klaus Wesiak (Frankfurt on the Main) and André Koch (Museum A. Koenig, Bonn) on the successful keeping and breeding of *Varanus juxtindicus* (see *Biawak* 3(4):106-121). Following the lunch break and a photograph of all participants, the debate with Aktion Tier took place. The discussion was opened by Silvia Macina, who reported on the current efforts of the DGHT in regards to the public discussion about the keeping of dangerous animals in Germany. Her detailed statements demonstrated the importance of the cooperation between the DGHT and responsible authorities of the various German federal states. Afterwards, Ursula Bauer from Aktion Tier discussed their campaign against the keeping of exotic animals in captivity with the attending members of the AG Warane. Prior to the meeting, heated discussions about the postulations of the animal welfare organization were caused by a controversial television documentary by Aktion Tier. Within the objective, but emotional discussion, some biased opinions were corrected. It soon became obvious that both parties shared one common goal: to guarantee the reasonable and responsible husbandry of reptiles in captivity. Bad seeds among reptile keepers should be identified, and access to dangerous animals such as venomous snakes and large monitor lizards should be better controlled. To achieve this goal, comprehensive educational work is necessary for newcomers. The general agreement was that the discussion between animal rights activists and animal keepers should continue in the future.

Following the debate, Thomas Hörenberg (Stuttgart) gave a lecture on the husbandry and breeding of *V. macraei*, and a successful caesarean section in *V. tristis orientalis*. In another afternoon talk, Monika Labes (Germering) gave a power point presentation on the husbandry and breeding of *V. exanthematicus*. Her detailed data provided a good overview of the development of the juveniles. After a short coffee break, André Koch (ZFMK, Bonn) talked about the discovery of some new Southeast Asian monitor lizards (see page 69 of this issue). The long meeting was concluded with a talk by Jochen Meyer (Stuttgart) on the captive breeding of *V. rudicollis*.

The general meeting of the AG Warane, with the election and appointment of new board members, will take place on 4 September 2010 during the annual meeting of the DGHT at the Senckenberg Museum in Frankfurt on the main. Further information will be available soon on the AG Warane homepage at www.agwarane.de, or contact Kay Uwe Dittmar (working group leader) at dittmar@ag-warane.de or André Koch (scientific leader) at a.koch.zfmk@uni-bonn.de.

Attendees of the second annual meeting of the AG Warane held in Hanau, Germany on 24 April 2010.

ARTICLES

Biawak, 4(2), pp. 50-58

Overview on the Present Knowledge on *Varanus mabitang* Gaulke and Curio, 2001, Including New Morphological and Meristic Data

MAREN GAULKE

GeoBio-Center Ludwig-Maximilians-University,
Richard-Wagner-Strasse 10, 80333 Munich, Germany
E-mail: mgaulke@web.de

Abstract: *Varanus mabitang*, a large arboreal monitor lizard, is endemic to the island of Panay in the central Philippines. It is confined to lowland evergreen rainforest, where it depends on a variety of forest fruits for food, and on tall forest trees for shelter. This habitat, and consequently also *V. mabitang*, are highly endangered because of ongoing logging and slash and burn activities. Measurements taken during field surveys give an average snout-vent length of 54.2 cm for adults; the largest measured animal had a total length of 175 cm. Scale counts show that meristic characters such as the number of transverse dorsal and ventral scales, and scales from rictus to rictus, are highly variable in this species.

Introduction

Unique to the Philippines is a small group of large and mainly arboreal monitor lizards. So far, they are only known from the Luzon faunal region in the north of the Archipelago (*Varanus olivaceus* Hallowell, 1856; *V. bitatawa* Welton, Siler, Bennett, Diesmos, Duya, Dugay, Rico, Weerd and Brown, 2010) and from Panay Island, which is part of the West Visayan faunal region in the center (*V. mabitang* Gaulke and Curio, 2001). These closely related species can be easily distinguished from all other monitor lizards by a combination of morphological and behavioural characters, among them blunt teeth, the presence of a large caecum, and a partly frugivorous diet. Their hemipenial and hemiclitoral morphology strongly supports a wide phylogenetic distance from other monitor lizards, and confirms the validity of the subgenus *Philippinosaurus* (erected by Mertens, 1959; discussed in Böhme, 1995; Ziegler and Böhme, 1997; Ziegler *et al.*, 2005). Due to their interesting and untypical varanid feeding habits, and their official conservation status (*V. olivaceus* is listed as vulnerable and *V. mabitang* as endangered in the IUCN Red List of threatened species), both species were, and are subject to intensive field investigations (e.g. Auffenberg, 1988; Bennett, 2001; Gaulke *et al.*, 2005, 2007; Gaulke and Demegillo, 2008).

Investigations on the feeding habits of *V. mabitang*, based on the examination of fecal pellets, disgorged stomach contents, feeding observations, and stable isotope analyses (a non-invasive method to gain insight into food web structures; Struck *et al.*, 2002; Gaulke *et al.*, 2007), revealed that this varanid is even more specialized for a frugivorous diet than *V. olivaceus*. In the diet of the latter species, land snails are of significant importance (Auffenberg, 1988; Bennett, 2001), while land snails and other carnivore food items comprise only a very small part of the diet of *V. mabitang*. In *V. mabitang*, we found evidence of folivory, which is not indicated in *V. olivaceus* (Gaulke *et al.*, 2007). This highly specialized diet is certainly the main limiting factor for the distribution of *V. mabitang* on Panay (Fig. 1). It is

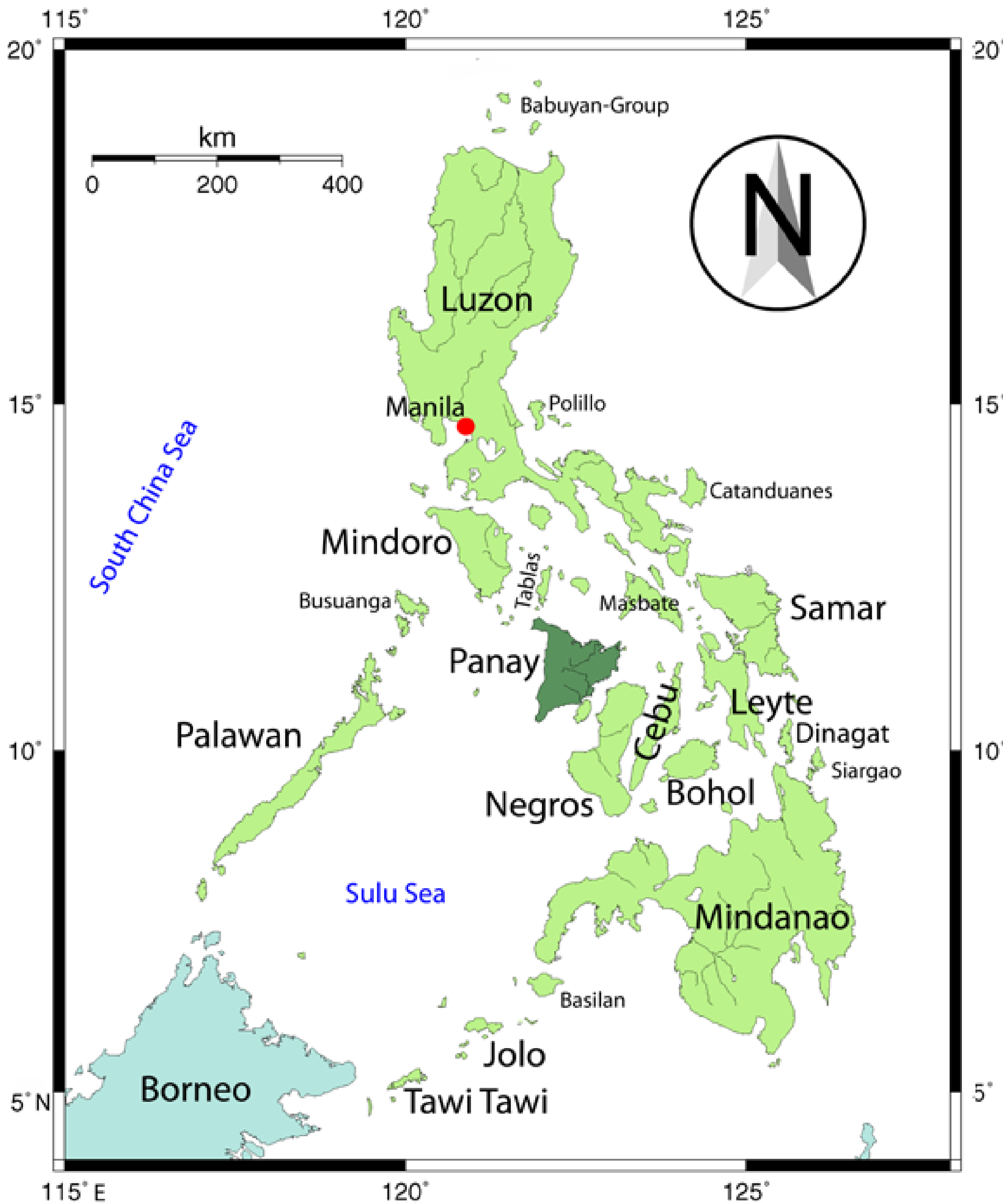


Fig. 1. Map of the Philippines. Panay Island, the range of *Varanus mabitang*, is indicated in dark green. Drawing by A.V. Altenbach.

confined to the evergreen lowland dipterocarp forest (Fig. 2), where it feeds on the fruits of at least 20 different forest trees. Most important are the fruits of screw palms (*Pandanus* spp.) and some palms (Family Arecaceae), whereas the fruits of different fig tree species (Family Moraceae) and others are less frequently eaten (Gaulke *et al.*, 2007). The population density of both *V. mabitang* and its preferred food trees, are highest below 500 m asl. Few specimens of *V. mabitang* were detected at higher elevations, with a maximum altitudinal distribution at around 1000 m asl.

Varanus mabitang are rarely sighted on the ground, usually while feeding on fallen fruits or basking in exposed areas. They spend most of their time resting on branches in the canopies of tall trees, or in tree cavities in the upper part of the trunk (Gaulke *et al.*, 2005).

Fig. 2. Typical habitat of *V. mabitang*, the lowland evergreen rainforest along the Central Panay Mountain Range.

Radiotelemetric observations of several individuals show that they do not use the same resting trees, but make use of all adequate trees (preferably very tall, with a smooth trunk) within their individual ranges. One specimen, for example, used at least 70 different resting trees within a period of two years. The detailed results of the radiotelemetric study will be published in a forthcoming report (Gaulke, in prep.).

Since the description of *V. mabitang* (Gaulke and Curio, 2001), which was based on the holotype (PNM 7272) and some additional data on one captured and subsequently released individual, several additional specimens have been examined. Here, data from these examinations are presented to show the range in size and the rather high variability of some of the meristic characters of *V. mabitang*.

Material and Methods

Twenty-five specimens of *V. mabitang* were captured between 2001 and 2009. All of them were released at their capture sites after taking measurements and scale counts, and marking them permanently with passive integrated transponders. To minimize stress, only some of the standard measurements and scale counts were taken, namely snout-vent length (SVL), tail length (TaL), mass, transverse rows of ventrals and dorsals from the gular fold to the insertion of hindlegs, scales from rictus to rictus, and the number of enlarged supraoculars. Measurements were taken with a tape measure to the nearest cm or mm, depending on the behaviour of the respective animal. While most specimens were very timid during handling (Fig. 3) and could be easily examined, a few were more lively, and did not relax their muscles during measuring. Weights were taken with +/- 10 g accuracy in small individuals, and +/- 100 g in the largest individuals (a more exact balance did not make sense, since the animals usually did not have empty stomachs even after two days, the maximum time an animal was kept before bringing it back to its capture

Fig. 3. Even large individuals of *V. mabitang* are usually very relaxed during examination.

Fig. 4. *Varanus mabitang* during the counting of transverse ventral scale rows.

site). While counting, the scales were marked with a pencil in order not to lose track (Fig. 4). Nevertheless, all scale counts were taken three times to receive reliable results.

Results and Discussion

Table 1 gives the lengths and masses of *V. mabitang*, compared to data from *V. olivaceus* and *V. bitatawa*. Not all data can be directly compared. Auffenberg (1988) dissected all of the examined specimens, and therefore could safely distinguish between males and females, and between mature and immature individuals. Consequently, he separated his measurements of adults according to sex, showing that males attain a much larger length than females. Not all of the examined *V. mabitang* could be sexed with certainty (e.g., males were identifiable when everting their hemipenes during handling), since probing of the hemipenal pockets did not show clear results. Only two of the 25 examined specimens (with a SVL of 34 and 38 cm, respectively) were considered as not mature, based on Auffenberg's data containing no mature individuals with a SVL of less than 40 cm. Table 1 shows that the average length of adult *V. mabitang* is slightly larger than *V. olivaceus*, and lower than *V. bitatawa* (so far based on only three examined specimens), while the average mass of adult *V. mabitang* is slightly lower than *V. olivaceus*. The mass difference between *V. mabitang* and *V. olivaceus* is more pronounced in smaller individuals (Gaulke *et al.*, 2005) than in large ones. The largest *V. mabitang* measured to date had a total length of 175 cm. However, several hunters or former hunters have reported animals of more than two metres in length.

The Tal/SVL ratio of *V. mabitang* ranges from 1.36–1.61; a relation between size and Tal/SVL ratio is not evident. Nevertheless, this might prove to be different when hatchlings and young juveniles are examined.

Table 2 shows the variability of some meristic characters of *V. mabitang*, *V. olivaceus*, and *V. bitatawa*. The range of the scale counts is higher in *V. mabitang* when compared to both sister species. The average numbers of the transverse rows of ventrals and dorsals are distinctly higher in *V. mabitang*, even though the highest ventral counts for *V. olivaceus* are overlapping with the lowest ventral counts for *V. mabitang*. Another scale count given in the species diagnosis as a distinguishing character between *V. mabitang* and *V. olivaceus* turns out to be of no value when looking at more material. While the number of scales from rictus to rictus is 70 in the holotype, the new counts show that this was untypically high. The range in rictus to rictus counts turned out to be rather high in *V. mabitang*, with an only slightly higher average count than in *V. olivaceus*, while it is comparably high in *V. bitatawa*.

Table 3 summarizes the coloration differences between the three species. Nothing new can be added here. All examined *V. mabitang* were almost uniformly dark (Figs. 3 & 4), as compared to the much lighter and distinctly banded *V. olivaceus*, and the very brightly colored *V. bitatawa*. No hatchlings of *V. mabitang* were seen during the surveys, though the youngest examined individuals are completely dark, just as the adults (Fig. 5). According to interviewed hunters, even hatchling *V. mabitang* are uniformly dark. Hatchlings and juvenile *V. olivaceus* are more brightly coloured and patterned than the adults (Fig. 6), as is typical for many varanids.

Table 1. Length and mass measurements of *Varanus mabitang*, *V. olivaceus*, and *V. bitatawa*. Data for *V. olivaceus* from Auffenberg (1988); data for *V. bitatawa* from Welton *et al.* (2010).

	V. mabitang			*V. olivaceus*			*V. bitatawa*		
Measurements	Range	Average	N	Range	Average	N	Range	Average	N
SVL (cm)	42-70	54.2	23	48.5-73	51.2	99	49.0-76.6	62.3	3
TaL (cm)	63-107	82	23	largest male: 102.5, largest female: 87.2	-	-	69.4-103.6	89.3	3
Ratio TaL/SVL	1.36-1.61	1.45	23	largest male: 1.40, largest female 1.54	-	-	1.35-1.55	1.44	3
Total Length (cm)	105-175	136	23	largest male: 175.5, largest female: 144	-	-	118-180	152	3
Mass (g)	1000-8000	3060	23	-	3120	97	9000		1

Table 2. Scalation characters of adult *V. mabitang*, *V. olivaceus*, and *V. bitatawa*. Data for *V. olivaceus* from Auffenberg (1988, N^1) and Gaulke and Curio (2001, N^2); data for *V. bitatawa* from Welton *et al*. (2010).

	V. mabitang			*V. olivaceus*			*V. bitatawa*		
Scale Counts	Range	Average	N	Range	Average	N	Range	Average	N
Transverse rows of ventrals, counted from gular fold to a theoretical line connecting the insertion of hindlegs ventrally	111-143	127	22	101-121	109	N^1= 106	106-110	108	3
				95-107	104	N^2= 5			
Transverse rows of dorsals, counted from dorsal side of gular fold to a theoretical line connecting the insertion of hindlegs dorsally	124-175	136	18	105-122	112.2	N^2= 5	113-127	119	3
Scales from rictus to rictus, counted in a straight line across head	52-70	61	18	50-61	58.4	N^1= 106	69, 78	-	2
				51-61	56.5	N^2= 4			
Number of distinctly enlarged supraoculars on each side	0-15	3.7	20	0-14	-	N^1= 106	-		
Texture of ventrals	Strongly keeled		25	Feebly keeled		N^1= 106	-		
				Smooth		N^2= 6			

Table 3. Coloration of *V. mabitang*, *V. olivaceus*, and *V. bitatawa*. Data for *V. olivaceus* from Auffenberg (1988) and Gaulke and Curio (2001), data for *V. bitatawa* from Welton *et al*. (2010).

	Varanus mabitang	*V. olivaceus*	*V. bitatawa*
Dorsal coloration	Black or blackish-grey, with tiny yellow markings on the posterior part of some scales of neck, back, and extremities (N=26)	Greenish-grey, with darker transverse bands across neck, back, and tail; extremities irregularly mottled yellowish-olive and grey (N=112)	Black, with constrasting golden yellow transverse rows of ocelli across back and golden yellow bands across tail
Ventral coloration	Dark grey to blackish-grey, without pattern (N=26)	Greyish, greyish-green, or yellow-grey, three to four longitudinal brownish black to black stripes on throat (N=112)	Darkish throat region

Fig. 5. Head and neck region of a young *V. mabitang*.

Fig. 6. Young specimens of *V. olivaceus* are brightly coloured; photo taken in the Avilon Montalban Zoological Park on Luzon.

Fig. 7. *Varanus mabitang* within its natural habitat.

Prospects

The future survival of *V. mabitang* depends on the existence and persistence of the most endangered ecosystem on Panay, the primary lowland evergreen forests (Fig. 2). This forest type is dominated by huge dipterocarps, and harbours a comparatively dense population of the preferred *V. mabitang*-food trees. Once in a while a *V. mabitang* sighting is reported from more open areas: along the forest edge, within secondary growth, or even from riverbanks in the open. However, these sightings have to be regarded with some reservation. Even though an occasional individual might be seen along the forest edge or in secondary forests of areas consisting of a patchwork of primary and secondary growth, this does not contradict their dependency on primary forests for feeding, resting, and most certainly breeding. Besides, sometimes "*V. mabitang*-sightings" actually refer to melanistic variants of *V. nuchalis*, a member of the *V. salvator* group which is found in different habitats, including primary lowland forests, but also cultivated areas. As experienced on more than one occasion, even biologists sometimes mistake both species. When asked to examine a newly caught "*V. mabitang*", it sometimes turned out to be the much more common and widespread *V. nuchalis*.

In most areas, the population status of *V. mabitang* has already reached a critical stage. If the ongoing habitat destruction through illegal logging and slash and burn activities cannot be stopped within the next few years, the existence of this varanid is seriously threatened, and its rapid extinction is likely.

Acknowledgements- The field investigations were part of the work of the Philippine Endemic Species Conservation Project of the Frankfurt Zoological Society, formalized under the aegis of a Memorandum of Agreement with the Department of Environment and Natural Resources (Quezon City, Philippines). The help of the Protected Areas and Wildlife Bureau is gratefully acknowledged.

The surveys were sponsored by the Patrons for Biodiversity (BIOPAT e.V., www.biopat.de) and the Frankfurt Zoological Society (FZS, www.zgf.de), and supported by the German Society for Herpetology and Herpetoculture (DGHT, www.dght.de). Their generous support is highly appreciated.

I am most grateful to the field assistants J. Mangga,

R. Mangga, G. Operiano, N. Paulino, and R. Paulino, and their supervisor A.D. Demegillo. The veterinarian E. Sanchez implanted the transponders. Without the experience and enthusiasm of them, none of the surveys and examinations would have been possible.

Thanks are due to D. Bennett, A. Koch and an anonymous reviewer for their helpful comments on the manuscript.

This is publication No. 82 of the Philippine Endemic Species Conservation Project.

References

Auffenberg, W. 1988. Gray's Monitor Lizard. University Presses of Florida. Gainesville, Florida.

Bennett, D. 2001. Wildlife of Polillo Island, Philippines. University of Oxford – University of the Philippines at Los Banos Polillo '99 Project, Final Report.

Böhme, W. 1995. Hemiclitoris discovered, a fully differentiated erectile structure in female monitor lizards (*Varanus* spp.) (Reptilia: Varanidae). Journal of Zoological Systematics and Evolutionary Research 33: 129–132.

Gaulke, M. and E. Curio. 2001. A new monitor lizard from Panay Island, Philippines. Spixiana. 24(3): 275–286.

Gaulke, M. and A.D. Demegillo. 2008. The Mabitang: large fruit-eating monitor of the Philippines- *Varanus mabitang*. Reptilia 59: 39–46.

Gaulke, M., V.A. Altenbach, A. Demegillo and U. Struck. 2005. On the distribution and biology of *Varanus mabitang*. Silliman Journal 46: 89–117.

Gaulke, M., A.V. Altenbach, A. Demegillo and U. Struck. 2007. On the diet of *Varanus mabitang*. Pp. 228-239. In Horn, H-.G., W. Böhme and U. Krebs (eds.), Advances in Monitor Research III. Mertensiella 16, Rheinbach.

Mertens, R. 1959. Liste der Warane Asiens und der Indo-autralischen Inselwelt mit systematischen Bemerkungen. Senckenbergiana Biologica. 40: 221–240.

Struck, U., A.V. Altenbach, M. Gaulke and F. Glaw. 2002. Tracing the diet of the monitor lizard *Varanus mabitang* by stable isotope analysis (delta 15N, delta 13C). Naturwissenschaften 89: 470–473.

Welton, L. J., Siler, C. D., Bennett, D., Diesmos, A., Duya, M. R., Dugay, R., Rico, E. L. B., Van Weerd, M. and R. M. Brown 2010. A spectacular new Philippine monitor lizard reveals a hidden biogeographic boundary and a novel flagship species for conservation. Biology Letters, doi: 10.1098/rsbl.2010.0119

Ziegler, T. and W. Böhme. 1997. Genitalstrukturen und Paarungsbiologie bei squamaten Reptilien, speziell den Platynota, mit Bemerkungen zur Systematik. Mertensiella 8: 1–207.

Ziegler, T., Gaulke, M. and W. Böhme. 2005. Genital morphology and systematics of *Varanus mabitang* Gaulke & Curio, 2001 (Squamata: Varanidae). Current Herpetology 24(1): 13–17.

Received: 30 March 2010; Accepted: 12 May 2010

Biawak, 4(2), pp. 59-63

Preying Possum: Assessment of the Diet of Lace Monitors (*Varanus varius*) from Coastal Forests in Southeastern Victoria

TIM JESSOP [1, 2], JAKE URLUS [3,4], TIM LOCKWOOD [3] and GRAEME GILLESPIE [2]

[1]*Department of Zoology, University of Melbourne*
Parkville, Vic 3010, Australia

[2]*Department of Wildlife Conservation and Research, Zoos Victoria*
Parkville VIC 3052, Australia

[3]*School of Life and Environmental Sciences, Deakin University*
Burwood, Vic 3125, Australia

[4]*AECOM, Melbourne, VIC 3000, Australia*

Correspondence to Tim Jessop, E-mail: tjessop@unimelb.edu.au

Abstract: Across much of its range, the lace monitor (*Varanus varius*) overlaps with a diversity of potential prey items. Previous dietary studies suggest that preferred prey tend to reflect common and often easily acquired prey including carrion. We investigated the diet of *V. varius* from relatively pristine mesic coastal forest in southeastern Victoria, Australia. In our study, the diet of *V. varius* was dominated by the ringtail possum, representing 63.15% of prey ingested. Carrion comprising swamp wallabies were the next most important food item and comprised 31.57% of the sample. We also noted a single observation (5.2%) of the consumption of a short-beaked echidna. Invertebrate prey comprising larvae and pupae of beetle, butterfly and moth species were also relatively frequently ingested. However, our results indicate a substantial preference for a single semi-arboreal prey item. The ringtail possum is also the staple for other predators in this area including introduced predators. We discuss the potential conservation and wildlife management implications between *V. varius* and introduced predators in light of their overwhelming preference for the ringtail possum.

Introduction

In eastern Australia, the lace monitor (*Varanus varius*) is one of the largest native terrestrial predators alongside the Dingo (*Canis lupus dingo*) and pythons. *Varanus varius* is distributed continuously along the east coast of Australia from Cape York Peninsula in Queensland to central Victoria, with a disjunct population also found in eastern South Australia (Cogger, 1994). This monitor lizard may exceed 2 meters in length and weight up to 7 kg (but much heavier in modified landscapes or captivity) (Cogger, 1994; Guarino, 2001; Weavers, 1989).

Varanus varius has a generalist diet (comprising many different prey taxa), but still, it comprises predominantly small to medium-sized mammals, alongside the ingestion of large prey, via carrion, including kangaroos, wallabies and domestic livestock (Guarino, 2001; Weavers, 1989). In existing studies on *V. varius*, mammals represented on average 66-78% of the dietary items ingested (Guarino, 2001; Weavers, 1989). However, one limitation of previous dietary information was that study areas overlapped considerably with the availability of introduced mammals (domestic livestock or introduced pest species) that were ingested as prey or carrion. For example, introduced rabbits, sheep and horses all feature predominantly in the diet of *V. varius* (Guarino, 2001; Weavers, 1989). The most common native prey in the diet of *V. varius* was also obtained from carrion and comprised large macropods including grey kangaroos (*Macropus giganteus)*, red-necked wallabies (*M. rufogriseus*) and swamp wallabies (*Wallabia bicolor*). Carrion from macropods may be relatively common in habitats where drought is prevalent or rainfall variation drives pronounced food availability for native herbivores (Guarino, 2001). Such events result in pulses of macropod mortality that supplies carrion to the predator guild including *V. varius*.

Hence, an effect of exotic prey and high carrion availability is that it may result in *V. varius* diets that are likely to be substantially different from populations occupying more pristine mesic forest habitats. In this study, we examined the frequency and type of prey ingested by *V. varius* in relatively pristine mesic coastal forests in the East Gippsland area of southeast Victoria, Australia.

Methods

During the Australian summers of 2007/2008, 2008/2009 and 2009/2010, we captured 143 *V. varius* using box traps, hand capture and noose pole. All lizards were captured from the coastal forests in Cape Conran State Park and Murrungowar State Forest in East Gippsland. From these animals, we opportunistically collected 13 dietary samples as a result of incidental regurgitation by some individuals (body mass 1.25-5.4 kg). A further six direct observations of prey ingestion by *V. varius* were also included for analysis.

Results

With respect to mammalian prey items found within the diet of *V. varius*, the ringtail possum (*Pseudocheirus peregrinus*) was by far the most common prey item representing 63.15 % of prey ingested (Table 1, Fig. 1). The majority of possums also appeared to have been swallowed whole as the regurgitated carcasses were largely intact (Fig. 2). In our study area, only two other mammalian items were recorded ingested by *V. varius*; the swamp wallaby (*W. bicolor*) comprising 31.57% of the diet, and a single observation of a short-beaked echidna (*Tachyglossus aculeatus*; Fig. 3). In all cases, consumption of swamp wallaby was obtained from carrion (from direct observations). Invertebrate prey was also found in the diet of *V. varius* and comprised predominantly larvae and pupae from unidentified beetle, butterfly and moth species.

Discussion

The forests of East Gippsland are largely intact and free of introduced prey items (*e.g.*, rabbits and livestock), hence the items ingested by lace monitors here may be presumed to reflect a natural diet. *Varanus varius* consumed both vertebrate and invertebrate prey but consumed ringtail possums above all other prey. This possum is the most common arboreal mammal in these coastal forests and its high rate of dietary preference by this lizard seems most likely to reflect its availability and ease of capture. *Varanus varius* are highly adept at

Table 1. Frequency of prey occurrence of taxonomic groups noted from stomach contents and via direct visual observations of *Varanus varius* (number of samples= 19).

Prey	Frequency	%
Mammals		
Ringtail possum (*Pseudocheirus peregrinus*)	12	63.15
Swamp wallaby (*Wallabia bicolor*)	6*	31.57
Short beaked echidna (*Tachyglossus aculeatus*)	1	5.2
Invertebrates		
Araenae (spiders)	1	5.2
Coleoptera (beetles)	2	10.54
Orthoptera (grasshopers, crickets)	3	15.6
Lepidoptera (butterflies, moths)	3	15.6

** Prey type eaten as carrion*

Fig. 1. A regurgitated dietary sample from a 3.6 kg. *Varanus varius* captured in the coastal forests of southeastern Victoria. The prey items comprise ringtail possum and beetle larve. Photograph by **Tim Jessop**.

Fig. 2. A sub-adult *V. varius* (ca. 1 kg) attacking a juvenile ringtail possum (ca. 0.5 kg) that it subsequently consumed. Ringtail possums are inactive during the day and often reside in dreys (a leaf, grass and stick shelter) constructed in the branches of trees, including saw banksias (*Banksia serrata*) as pictured here. Presumably this makes the possums easy and conspicuous prey, and hence, the apparent high preference for such prey in the diet of *V. varius*. Photograph by **Jake Urlus**.

Fig. 3. Quills from a juvenile short-beaked echidna (*Tachyglossus aculeatus*) were found within the regurgia of a *V. varius* and indicate the potential, albeit rare, for these lizards to consume some awkward prey. Photograph by **Tim Lockwood**.

climbing, enabling them to seek out ringtail possums, which are nocturnal, but shelter by day within arboreal dreys (shelters comprising leaves, sticks and grass). These results contradict those of other studies which have shown that arboreal mammals such as possums and gliders are relatively rare in the diet of *V. varius* (Guarino, 2001). The frequency of large macropod prey (*e.g.*, swamp wallabies) ingested as carrion (31.6%) in this study was similar to the 26 and 30% (*e.g.*, grey kangaroo/red-necked wallabies) found in other dietary studies (Guarino, 2001; Weavers, 1989). However, the source of mortality providing macropod carrion in our study appeared to be largely due to road fatalities, compared to the environmental reasons noted elsewhere (Guarino, 2001; Weavers, 1989). Consequently, in the more remote forest areas where road traffic is absent or minimal, availability of carrion may be reduced, requiring a greater reliance on active foraging by *V. varius* to meet their nutritional requirements. This is likely to suggest that *V. varius* favors the most profitable prey in its landscape, and this leads to significant spatial variation in diet of this species pending the composition of the prey or carrion base.

Our results confirm that the diet of *V. varius* reflects a preference for both common and easily-acquired prey items within its coastal forest landscape. Interestingly, the mammalian diet of *V. varius* reported here is also very similar to that of introduced predators inhabiting this region of eastern Victoria (Triggs *et al.*, 1984). Like *V. varius*, foxes, cats and dogs were also found to ingest ringtail possum at high frequencies ranging between 38-58% of total prey consumption (Triggs *et al.* 1984). From a conservation and management perspective, the overlap of marsupial prey items between *V. varius* and introduced predators in the lowland coastal forest area of southern Australia suggests the possibility for resource-based competition. Conceivably, introduced predators should have a competitive advantage over native predators as native prey lack co-evolutionary history with novel predators and are therefore more easily preyed upon (Glen *et al.*, 2009). If sufficiently strong, competition could lead to multiscale responses in native predators. In the case of *V. varius*, like most ectotherms with indeterminant growth, a reduction in prey availability (*e.g.,* ringtail possums) could lead to delays in growth to sexual maturity and reproductive effort. Such individual level responses would reflect nutritional constraints imposed by introduced predator competition. If severe, such competition could have broader implications for the demography of varanid populations and potentially cause declines. However, to date, no studies have been undertaken within the context of understanding the potential impacts of introduced predators on monitor populations. Hence, we strongly advocate natural resource managers consider the impacts of introduced predators on *V. varius* to assess their vulnerability to resource competition.

Acknowledgements- We acknowledge two anonymous reviewers for providing feedback and recommendations on the initial manuscript. We would also like to thank Zoos Victoria for funding our field research.

References

Cogger, H. 1994. Reptiles and Amphibians of Australia. Reed Books, Sydney Australia. 788 pp.

Dickman, C.R. 1996. Impact of exotic generalist predators on the native fauna of Australia. Wildlife Biology 2: 185-195.

Glen, A.S., P.J. de Tores, D.R. Sutherland and K.D. Morris. 2009. Interactions between chuditch (*Dasyurus geoffroii*) and introduced predators: a review Australian Journal of Zoology 57(5): 347–356.

Guarino F. 2001. Diet of a large carnivorous lizard, *Varanus varius*. AustralianWildlife Research 28: 627–30.

Triggs, B., H. Brunner, and J.M. Cullen. 1984. The food of fox, dog and cat in Croajingalong National Park, south-eastern Victoria. Australian Wildlife Research 11: 491–499.

Weavers, B.W. 1989. Diet of the lace monitor (*Varanus varius*) in south-eastern Australia. Australian Zoology 25: 83–85.

Received: 30 March 2010; Accepted: 5 May 2010

TRANSLATIONS

**Editor's note*: Translations are intended to supplement the original text to help the reader interpret the information presented, and thus do not include original tables, figures, photographs, or references. For these materials, the reader should refer to the original publication.

Eidenmüller, B. and R. Wicker. 2005. Eine weitere neue Waranart aus dem *Varanus prasinus*-Komplex von der Insel Misol, Indonesien. Sauria 27(1): 3-8.

A Further New Monitor Species of the *Varanus prasinus* Complex from Misol Island, Indonesia

BERND EIDENMÜLLER AND RUDOLF WICKER
with figures by M. REISINGER

Translated by JAN PHILIP ØYEN
E-mail: janphilipoyen@gmail.com

Abstract- From Misol island, offshore to the south-west of the Vogelkop-peninsula, a new monitor species of the *Varanus prasinus* complex is described as *V. reisingeri* sp. n. The new species is distinguished from *V. prasinus* by its black ground color with a yellow pattern. It is distinguished from *V. macraei*, which occurs on Batanta, by its yellow dorsal pattern (*V. macraei* has a blue dorsal pattern). The dorsal coloration consists of yellow spots, which partially have black ocelli, arranged in 16 cross-rows. The ventral coloration is a bright yellow.

Introduction

In recent years, several new species of the subgenus *Euprepiosaurus* have been discovered and newly described to science. These are mostly species of the *Varanus indicus*-complex (*V. melinus* Böhme and Ziegler, 1997, *V. yuwonoi* Harvey and Baker, 1998, *V. caerulivirens* Ziegler *et al.*, 1999, *V. cerambonensis* Philipp *et al.* 1999, *V. juxtindicus* Böhme *et al.*, 2002).

Additionally, two new species of the *V. prasinus*-complex have been described recently (*V. macraei* Böhme and Jacobs, 2001 and *V. boehmei* Jacobs, 2003). These newly described species occur, as the others with the exception of *V. keithhornei*, on the islands surrounding New Guinea. This area probably holds more surprises regarding new species. A further two species of the *V. prasinus*-complex have been described: *V. keithhornei* (Wells and Wellington, 1985) from a rainforest region on the Cape York peninsula in Australia, and *V. telenestes* (Sprackland, 1991) from Rossel island, to the southeast of New Guinea. These species all have a black base-color.

The species described in this article was brought to our attention by M. Reisinger, who saw these animals at a dealer's shop during his last stay on Irian Jaya (Dec. 2004). He noted that this had to be a new taxon. While there, he researched the origin of the animals in question. From the dealer, he learned that these specimens were collected on Misol Island, southwest of the Vogelkop-peninsula.

We hereby describe the new monitor species as: *Varanus reisingeri* sp. n.

Holotype

SMF 83679, adult male, Misol Island, Indonesia, collected by native collectors, January 2005.

Description

Habitus slim. Total length 760 mm, SVL 280 mm, TL 480 mm, front leg length 72 mm, upper arm length 36 mm, lower arm length 36 mm; length of the fourth toe 37 mm; hind leg length 68 mm, thigh length 35 mm, lower leg length 33 mm; length of the fourth toe 35 mm. Shape of the head elongated, about twice as long as wide; Canthus rostralis slightly raised in the preocular region. Nasal region slightly raised, nostril oval, located closer to the tip of the snout than to the eye (1:1.36). Six scales between the eye and the nostril. Scaling of the upper side of the head is irregular, 5 interoculars present, irregular size (Fig. 5). Parietal eye clearly visible. Nuchal scales round, elongated towards the body, weakly keeled. Ventral side with very narrow, elongated, slightly keeled scales, 82 rows from the gular fold to the base of the hind legs; 87 rows around the mid-body, not forming complete rings. Also on the ventral side, the rows are not always continuous. Front legs (72 mm) longer then the hind legs (68 mm). Ventral side of the toes with enlarged black scales. Claws large, strongly curved and pointed.

The tail is round in cross section and prehensile. Scales are arranged in rings, dorsal caudal scales slightly keeled. The tail is about 1.7 times longer then the SVL. The holotype has a slightly distorted tail, which was probably caused by an injury. Therefore it is possible that the tail of “healthy” animals are relatively longer (see prospective paratypes). Base coloration is glossy black. Clusters of yellow spots on the nape and back form clear bands. Some spots show a black center. Banding on the nape is chevron-shaped, on the rest of the body the spots are arranged in 16 distinct rows. The scales are slightly keeled.

The scales on the head are yellow, the interstitial skin is black; tip of the snout is light yellow. The lower jaw is also light yellow. A double row of black scales, with a central row of small yellow scales which have a black center, starts in front of the eye and stretches along the head, until over the ear; the throat is bright yellow, without visible mottling.

The ventral coloration of the type specimen is bright yellow, only the interstitial skin is black. The scales on the legs are yellow with a black interstitial skin, more irregular on the front legs due to some of the scales being black.

The ventral side of the tail is bright yellow, the scales here are also slightly keeled.

Prospective Paratypes

Topotypics, two specimens which are still alive. When deceased, they will be deposited in the Senckenberg Museum.

Specimen 1.

Subadult male, origin: Misol Island, Indonesia, collected by native collectors, January 2005. Habitus, coloration and patterning is identical to the holotype. Because of this, only the differences are listed. Total length 673 mm, snout-vent length 248 mm, tail length 425mm; front leg length 60 mm, upper arm length 28 mm, lower arm 32 mm; length of the fourth toe 25 mm; rear leg length 65 mm, thigh length 32 mm, lower leg length 33 mm; Length of the fourth toe 32 mm. Nostril oval, located closer to the snout then to the eye (1:1.22). Five scales between the eye and the nostril. 5 scales between the eyes across the top of the head. Parietal eye visible. Eighty two rows of scales from the gular fold to the base of the rear leg, 88 scales around the mid body; not arranged in consistent rings. The front legs (60 mm) shorter then the rear legs (65 mm). The tail is approximately 1.7 times as long as the snout-vent length.

Specimen 2.

Subadult female, origin: Misol Island, Indonesia, collected by native collectors, January 2005. Habitus, coloration and patterning is identical to the Holotypus. Only the differences are listed. Total length 630 mm, snout-vent length 220 mm, tail length 410 mm; front leg length 53 mm, upper arm length 26 mm, lower arm length 27 mm; Length of the fourth toe 23 mm; rear leg length 58 mm, thigh length 28 mm, lower leg length 30 mm; Length of the fourth toe 27 mm. Nostril oval, located closer to the snout then to the eye (1:1.06). Five scales between the eye and the nostril. Five scales between the eyes across the top of the head. Parietal eye visible. Eighty seven rows of scales from the gular fold to the root of the rear legs; 88 scales around the mid body, not arranged in consistent rings. The front legs (53 mm) are shorter then the rear legs (58 mm). The tail is approximately 1.86 times as long as the snout-vent length.

Diagnosis

The *V. prasinus* complex is obviously organized around its center, New Guinea. All islands from which members of this closely related group have been described are located on the continental shelf which connects New Guinea with Australia, or is separated from it by a strait (Jobi Island, D'Entrecasteaux archipelago, Rossel Island). Heatwole (1987) noted that the sea level 14,000 years ago was about 120 m lower then today. Through the rise in sea level following the last ice age, the peripheral populations became isolated, and underwent independent development. The population of the D'Entrecasteaux archipelago, or Rossel Island, can be explained by drifting (*e.g.*, drift wood).

The new species from Misol clearly belongs to the *V. prasinus* complex, as it shows the typical characteristics of this group (slender habitus, prehensile tail). The species is distinguished from all other the other members of the *V. prasinus* complex by its coloration (*V. prasinus* and *V. kordensis* have a green ground color, *V. reisingeri* has a black ground color, with extensive yellow markings). From the other members of the *V. prasinus* complex which show a black ground color (*V. boehmei, V. p. beccarii, V. p. bogerti, V. keithhornei, V. macraei, V. telenesetes*), it is distinguished by its distinct markings on the back. These markings, in contrast to the blue markings of *V. macraei*, consist of yellow blotches, which are arranged in transverse rows. The new species is also distinguished from *V. boehmei* by its markings (*V. boehmei* has indistinct reddish to yellowish banding, while *V. reisingeri* has bright yellow blotches and ocelli on its back). It is distinguished from *V. p. beccarii* by its larger number of ventral scales (74 in *V. p. beccarii* vs. 82 in *V. reisingeri*). *Varanus telenesetes* on the other hand, has more rows of scales around the mid body (100 vs. 87 in *V. reisingeri*). Geographic separation should be enough to distinguish it from *V. p. bogerti*. Distinguishing it from *V. keithhornei,* from the Australian Cape York Peninsula, is possible by differences in ventral markings (white-grey in *V. keithhornei* vs. yellow in *V. reisingeri*) and the geographic separation of these two species.

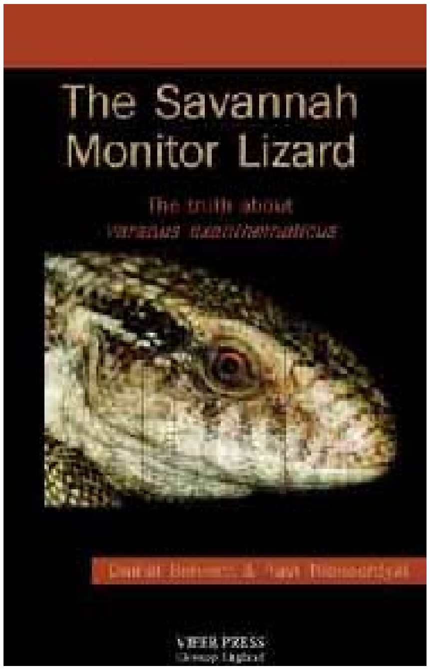
Etymology

We name this new species after Manfred Reisinger (Landshut, Germany), who gathered information about its origin, and supplied important information for the description. As the German common name, we suggest Reisinger's Baumwaran (= Reisingers tree monitor).

Distribution

The distribution of this monitor species seems to be limited to Misol Island, Irian Jaya, according to the information from local collectors in Sorong. Further enquiries and additional information about its occurrence and natural history is lacking.

Received: 19 April 2010; Accepted: 1 June 2010



The Savannah Monitor Lizard: The Truth About *Varanus exanthematicus*

DANIEL BENNETT and RAVI THAKOORDYAL
Viper Press, Glossop, UK. 2003. 84 pp.
Softcover. ISBN: 9780952663294

Reviewed by
PAUL RODRIGUEZ
E-mail: Bloodbat@cox.net

Over the past 20 years, there has been an abundance of books written on the proper husbandry of monitor lizards. I own at least three on the savannah monitor, *Varanus exanthematicus*, plus several others on monitor husbandry. So why do we need another one? It is my opinion that the savannah monitor is one of the two most misunderstood monitors regularly available to keepers (the Nile monitor, *V. niloticus*, being the other misunderstood monitor), which leads to many poorly maintained lizards. Thus, the quantity of books has not led to an increase in quality care for the monitors. However, the trend has changed with the publication of *The Savannah Monitor Lizard: The Truth About Varanus exanthematicus*. The information it offers should lead to healthier monitors and happier keepers.

The book is written in a logical format consisting of several sections. The main sections cover natural history and captive husbandry. Humor makes an appearance in several sections, and the information is the better for it. Although the present book is critical of previous husbandry books, such criticism is not belabored or personalized. The subsections are clear and concise while covering the critical elements. Although some subsections could probably have been combined, I actually like the amount of subsections. A new keeper should easily be able to find answers to some of the more common husbandry-related questions.

The book begins with a justification and a basic introduction to monitors. This information provides a nice foundation for the remainder of the content. A dichotomous key is provided for identifying all of the African monitors. Although such a key is unlikely to be used by many readers, it may prove its worth for new keepers unfamiliar with monitors, or potential keepers verifying a pet store label. I am disappointed that while the desert monitor, *Varanus griseus,* is characterized as a "bad tempered lizard," the Nile monitor is characterized as "lively." I think this characterization misses an opportunity to caution potential keepers about the generally poor disposition of Nile monitors.

The second section of the book covers savannah monitors in the wild. I found this section to be the most enjoyable. Readers who never keep monitors may enjoy this section on natural history, behavior, conservation status, and other topics. The content is enhanced by references to field studies and the inclusion of graphs representing quantitative data. Further credibility is gained when one realizes the author (DB) is citing some firsthand research experience. One disappointment is the generalized range map for the savannah monitor. The section contains numerous references to specific countries and physical regions. A more detailed map would provide context for those references.

The captivity section details the methods used for successful monitor care and reproduction. This section is unlike many monitor care books, and is refreshing. Novices and experts alike can gain some insight into improvements to care, and begin to see husbandry from the vantage point of the monitor. I appreciate the focus on monitor-friendly substrates and the warning that not all captive monitors will become tame. Heating is covered thoroughly, although I would have preferred see the "how should I check the temperatures" section mentioned before the recommended basking temperatures. I also find the foods section to be helpful for new keepers, and a good reminder for experienced keepers. I disagree with the emphasis on supplements, but this disagreement is minor. Aside from these minor points, I have a few more serious criticisms.

First, humidity is mentioned, but I am left uncertain what level of humidity the authors recommend. They mention the savannah monitor as a tropical lizard (p. 49); as a result, many keepers may inappropriately create a very wet, rainforest-type environment for their monitors. Second, consistent with previous monitor books, the authors suggest that additional monitors are not necessarily too much extra work. I find this suggestion an unfortunate carryover from older books. I have kept many monitors for many years, and even just one additional mouth to feed, and the extra space needed is noticeable. It is great when monitors get along in the same enclosure, but when problems arise, many people do not have available space for another large enclosure. This problem is compounded by the authors' suggestion that keepers should start with a few monitors, and that up to six juveniles will fit in a 91 cm (3 ft) aquarium (p. 46). Finally, I disagree with the statement that parasite checks are "absolutely vital" (p. 63). Ironically, if one follows all of the other advice in this book, parasite checks will be unnecessary, as a healthy monitor will keep parasites in check through natural means. These criticisms aside, the information contained in the section on captivity will lead to monitors that are healthier, happier, and more productive than those kept in the conditions described in previously published books.

The last section on further information is a nice addition. The reference list will be helpful to anyone interested in pursuing research articles, and the suggestion to travel to the home territory of savannah monitors is certainly a nice touch. Overall, *The Savannah Monitor Lizard: The truth About Varanus exanthematicus*, should be considered a required book for all new savannah monitor keepers. Even keepers of other monitors can benefit from the perspective of doing what is best for the monitor, and not what is easiest for the keeper.

Received: 5 June 2010; Accepted: 6 June 2010

Underestimated Diversity of Philippine Water Monitor Lizards (*Varanus salvator* Complex) Unraveled: a Contribution to the International Year of Biodiversity, 2010

The Philippine Archipelago comprises more than 7,000 tropical islands. This island nation is well known for its spectacular biological richness and high diversity of plants and animals. It is one of the biodiversity hotspots of our planet, a real megadiversity country. Despite this internationally recognized distinction, knowledge about the enormous natural heritage of the Philippines is still rudimentary and we are far from a complete species inventory of these islands. This is not only true for coral fishes or butterflies and other small insects, but also for the large predators in this region, the monitor lizards. Thus, many new species are described each year from the Philippines – and many more remain to be discovered in the future.

Traditionally, three water monitor lizard species are recognized from the Philippines. These are *Varanus cumingi* Martin, 1838, from the islands of the Greater Mindanao region in the southeast, *V. nuchalis* (Günther, 1872) from the central Philippine Greater Negros–Panay region, as well as *V. marmoratus* (Wiegmann, 1834), which has a disjunct distribution range including the islands of Greater Luzon, Mindoro, Greater Palawan, and Greater Sulu (see Fig. 1). In addition, two herbivorous monitor lizard species, *V. mabitang* and *V. olivaceus* from Panay and Luzon, respectively, inhabit the Philippine Islands. The former species was discovered only nine years ago (Gaulke and Curio, 2001) and the latter species was recently split into two distinct species (Welton *et al*., 2010).

Since Mertens' (1942) revision of the genus *Varanus*, the three Philippine taxa have been treated as subspecies of the wide-spread *V. salvator*. A recent study on the systematics and diversity of Southeast Asian water monitor lizards (Koch *et al*., 2007), however, showed that they actually represent distinct species that can be distinguished from each other and *V. salvator* by significant differences in color pattern and scalation features. These decisions are also partly corroborated by molecular genetic evidence (see Ast, 2001).

Now, in a recently published morphological revision,

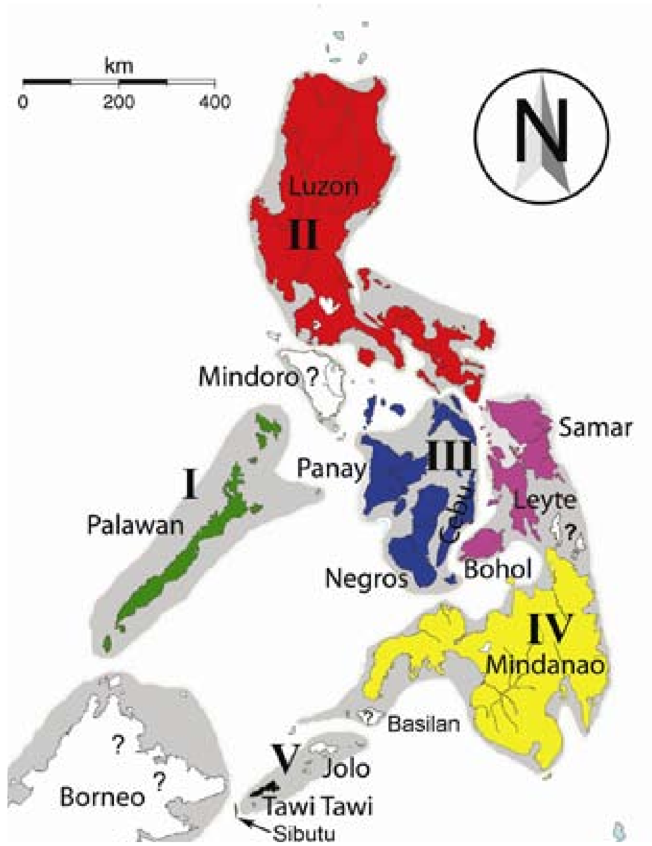


Fig. 1. Map of the Philippine Archipelago showing the distribution ranges of the six endemic water monitor lizard taxa: *Varanus marmoratus* = red; *V. nuchalis* = blue; *V. palawanensis* = green; *V. rasmusseni* = black; *V. c. cumingi* = yellow; and *V. cumingi samarensis* = purple. Question marks denote the water monitor populations from Mindoro, Basilan, and northern Borneo of unknown taxonomic status. The grey shaded areas indicate the extent of emerged land during global Pleistocene sea level low stands. Today, these former paleo-islands form five biogeographic subprovinces within the Philippines: I = Greater Palawan; II = Greater Luzon; III = Greater Negros–Panay; IV = Greater Mindanao; and V = Greater Sulu. Copyright **Maren Gaulke** & **André Koch.**

the Philippine members of the *V. salvator* complex were reinvestigated based on examination of numerous preserved voucher specimens in major European natural history museums, in combination with long-term studies in the field (Koch *et al*., 2010). As a consequence, three new taxa - two species and one subspecies- were identified as new to science. One main result was that the wide-spread *V. marmoratus*, with its disjunct island populations, actually represents a composite species, comprising at least three distinct taxa. Hence, the populations of Palawan, Balabac, the Calamian group and Sibutu, as well as those of Tawi–Tawi Island within the small Sulu Archipelago, were described as new species, viz. *V. palawanensis* (Fig. 2) and *V. rasmusseni* (Figs. 3A,B). The latter species is known from only two historical voucher specimens which were collected by the Danish Noona Dan Expedition in 1961. *Varanus rasmusseni* is considered endemic to the Sulu Archipelago, located between northern Borneo and Mindanao (Fig. 1). Due to its limited distribution range, the new species has to be treated as "vulnerable" according to the official criteria of the International Union for Conservation of Nature (IUCN 2001).

Although a large sample size of Philippine water monitor lizards was investigated, not all open questions could be answered. Thus, in the absence of voucher specimens, the taxonomic status of the monitor lizard population from Mindoro (Fig. 4) deserves further systematic investigations and has to be treated *incertae sedis* until new data are available. This is also true for the population of northern Borneo, which was hitherto allocated to the natural range of *V. s. macromaculatus* (Koch *et al*., 2007). However, the finding of *V. palawanensis* on the little island of Sibutu, belonging to the Sulu Archipelago off the coast of Sabah, northern Borneo (Fig. 1), suggests that this species might also occur on Borneo itself.

In addition, the morphological investigations revealed the colorful *V. cumingi* to be polytypic. The allopatric island populations from Samar, Leyte, and Bohol show diagnostic and geographically correlated color patterns distinct from the type locality Mindanao, warranting subspecific partition of this species. The new recognized subspecies was called *V. c. samarensis* after the island of Samar, from where the type specimens originated (Figs. 5 & 6). The nominotypic subspecies is restricted to Mindanao (Fig. 7), the second subregion of the Greater Mindanao subprovince (Fig. 1). In contrast, the various populations of *V. nuchalis* remain monotypic despite a considerable degree of polymorphism in color pattern ranging from individuals with large bright spots to nearly melanistic specimens. There is, however, no strict correlation between the different morphotypes of *V. nuchalis* and the islands inhabited. A summary of the respective distribution ranges and the most obvious distinguishing characters of the six Philippine members of the *V. salvator* complex are shown in Table 1.

Interestingly, the distribution ranges of the Philippine water monitor lizards reflect general biogeographic patterns of the Philippine Archipelago. Each species is endemic to one or few major modern-day islands constituting one of five faunistic subprovinces of the

Fig. 2. *Varanus palawanensis*, one of the new monitor lizard species from Palawan Island. Photograph by **Ingo Langlotz**.

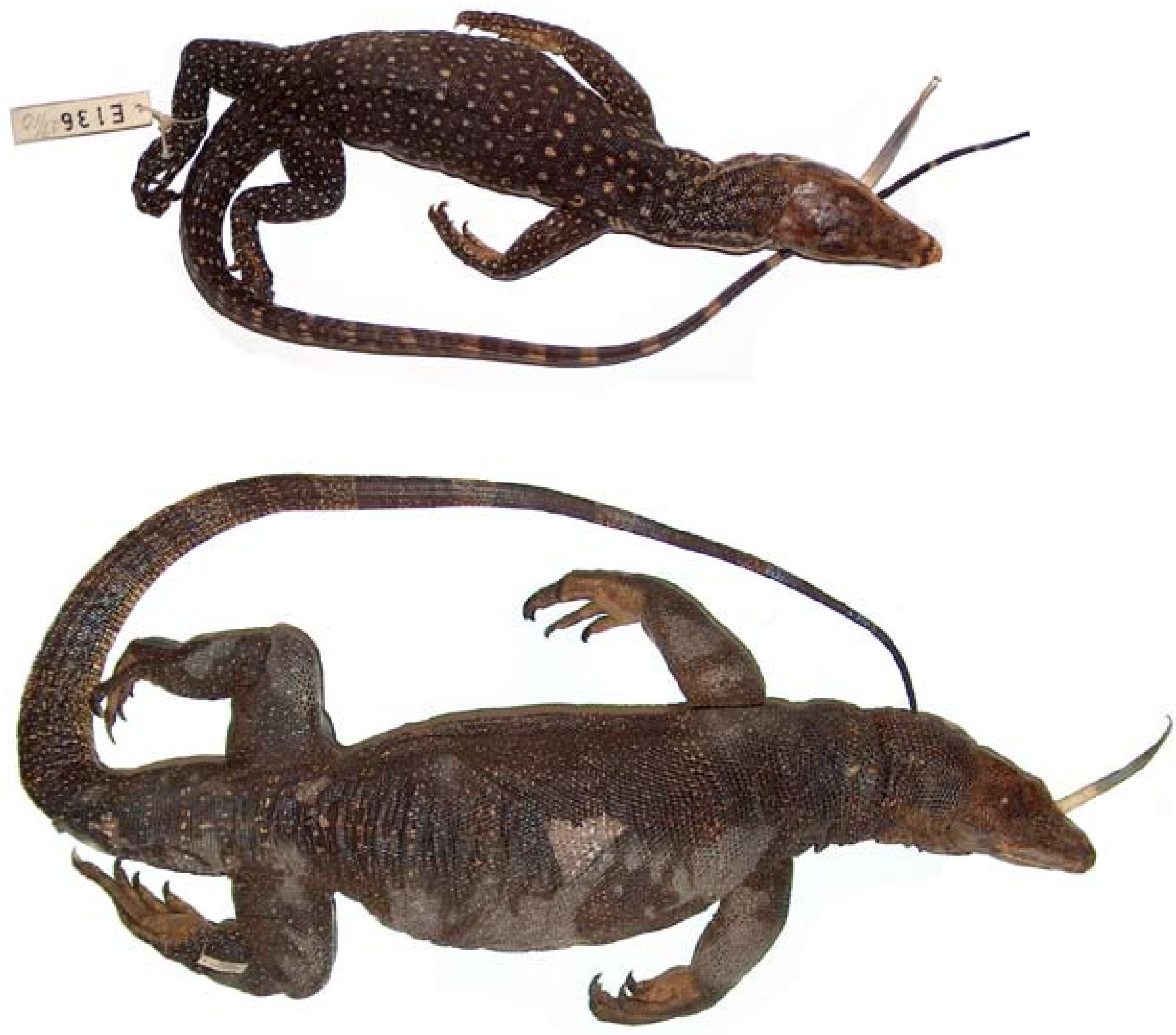


Fig. 3. *Varanus rasmusseni* is only known from the two specimens of the type series. This endemic species is characterized by a dorsal color pattern of many small bright spots in juveniles (A, shown is the paratype specimen ZFMK 89391, formerly ZMUC R42153) and a melanistic coloration in adults (B, the holotype ZMUC R42151). Photographs by **André Koch**.

Philippines (Fig. 1), which formerly represented larger land masses of several interconnected islands during Pleistocene glacial periods of global sea level low stands. This circumstance is amazing given the good swimming ability of water monitor lizards. However, similar observations of distinct and endemic water monitor lizard taxa in close proximity, separated merely by narrow but deep ocean channels, have been made on Sulawesi and its satellite islands in Central Indonesia (Koch *et al*., unpubl. data). Obviously, strong sea currents impeded a faunal exchange and hybridization between neighboring island populations in the past, thus warranting an independent evolution in geographical isolation once these oceanic islands had been successfully colonized. The potential ability to reproduce parthenogenetically without males, as has been demonstrated for several other monitor lizard species (*e.g.*, Lenk *et al.*, 2005, Watts *et al*., 2006), might have facilitated the establishment of new founder populations.

Remarkably, the newly described monitor lizards virtually double the number of known Philippine water monitor lizard taxa. These important findings together with two other monitor lizard species described in the first months of 2010 (see Welton *et al.*, 2010; Weijola and Sweet, 2010), the International Year of Biodiversity (http://www.cbd.int/2010/welcome/), reveal again the underestimated diversity of these CITES-relevant giant lizards in insular Southeast Asia.

Fig. 4. The taxonomic status of the water monitor lizard population from Mindoro Island is still unsolved. This specimen shows enlarged nuchal scales as typical for *V. marmoratus* from Luzon. Photograph by **Maren Gaulke**.

Fig. 5. This adult specimen of *V. cumingi samarensis* from Leyte Island shows the distinctive and rich in contrast dorsal color pattern. Photograph by **Maren Gaulke**.

Fig. 6. A juvenile specimen of *V. cumingi samarensis*, the new subspecies of Cuming's water monitor from the islands of Samar, Leyte, and Bohol. Photograph by **Maren Gaulke**.

Table 1. Distribution ranges and most obvious distinguishing characters of the six Philippine members of the *V. salvator* complex. Data taken from Koch *et al*. (2010). Values in parentheses represent mean ± standard deviation; n = number of specimens examined.

	V. palawanensis	***V. rasmusseni***	***V. marmoratus***	***V. nuchalis***	***V. c. cumingi***	***V. c. samarensis***
Distribution range (see Fig. 1)	Palawan island group, Sibutu (North Borneo?)	Tawi-Tawi island group (Sulu Islands)	Luzon and off-shore islands (Mindoro?)	Negros, Panay, Cebu, Masbate, Ticao	Mindanao and off-shore islands	Samar, Leyte, Bohol
Scales around midbody	129–178 (141.93 ± 11.55; n = 14)	152–157 (154.50 ± 3.54; n = 2)	115–145 (133.60 ± 8.53; n = 15)	136–169 (151.45 ± 9.55; n = 29)	121–150 (138.70 ± 8.27; n = 10)	130–152 (140.38 ± 7.91; n = 8)
Ventral scales from tip of snout to insertion of hind legs	155–176 (169.50 ± 6.49; n = 14)	183–187 (185.00 ± 2.83; n = 2)	158–180 (169.00 ± 7.60; n = 15)	159–176 (167.64 ± 4.63; n = 28)	149–175 (161.10 ± 6.67; n = 10)	155–165 (160.63 ± 3.54; n = 8)
Dorsal scales from hind margin of ear to insertion of hind legs	116–145 (127.14 ± 8.29; n = 14)	135–138 (136.50 ± 2.12; n = 2)	101–123 (110.80 ± 6.13; n = 15)	94–138 (109.45 ± 9.99; n = 29)	114–136 (121.18 ± 7.08; n = 11)	114–127 (119.38 ± 4.90; n = 8)
Scales around neck anterior to gular fold	93–116 (101.15 ± 6.18; n = 13)	120–129 (124.50 ± 6.36; n = 2)	72–105 (98.71 ± 8.30; n = 14)	85–106 (97.21 ± 5.71; n = 29)	86–102 (96.60 ± 4.74; n = 10)	89–104 (98.00 ± 5.07; n = 8)
Color pattern of head	mostly dark, sometimes with whitish markings, a bright temporal streak more or less pronounced	juveniles: brown with 3 indistinctive dark crossbands on snout; adults: dark brown; a bright temporal streak only in juveniles	dark, with 1–2 indistinct bright crossbands on snout	dark, with or without white markings	predominantly yellow, sometimes brownish, with few dark markings	predominantly black, with yellow markings
Color pattern of back	mostly dark, mottled with light bordered scales; sometimes with up to eight transverse rows of spots	juveniles: brown with 12 transverse rows of small spots;adults: dark brown mottled with single bright scales	dark, with or without 4–6 transverse rows of more or less distinctive larger spots	dark, with or without 4 more or less reduced transverse rows of spots, sometimes with bright medium stripe	black, with 5–6 indistinctive yellow transverse rows, sometimes with medio–dorsal stripe	black, with 6–8 transverse rows of more or less distinctive yellow spots, ocelli or markings
Color pattern of belly	whitish, with 7–11 more or less distinctive dark crossbands	juveniles: whitish with ca. 11 dark cross bars; adults: dark with indistinctive bright median bars	whitish, with 6–11 more or less distinct dark pointed bars or cross bands	entirely dark or yellowish with dark reticulate markings or indistinctive dark bars	yellow, with 8–11 more or less distinctive dark bars or crossbands	yellow, with 9–15 more or less distinctive dark bars or crossbands

Fig. 7. The nominotypic subspecies of *V. cumingi* is restricted to Mindanao and some smaller off-shore islands. Note the typical dorsal color pattern of indistinctive yellow transverse bands. Photograph by **Maren Gaulke**.

Finally, the recent revision of Philippine water monitor lizards is a convincing demonstration of the international importance of natural history museum collections as the archives of global biodiversity. Unfortunately, in times of limited public funding, necessary curatorial positions often remain unfilled once a scientist is retired. This gravely affects not only the relevant collections, but also the related field of study. Thus, one of the new monitor species, viz. *V. rasmusseni* (see Figs. 3A,B), which is known from only two specimens in the Zoological Museum of the University of Copenhagen (ZMUC), was named after the late Jens B. Rasmussen, former herpetologist in that museum, whose position was not reopened again. Thereby, the authors also want to call attention to the global taxonomy crisis.

References

Ast, J.C. 2001. Mitochondrial DNA Evidence and Evolution in Varanoidea (Squamata). Cladistics 17: 211-226.

Gaulke, M. and E. Curio. 2001. A new monitor lizard from Panay Island, Philippines. Spixiana 24: 275-286.

International Union for Conservation of Nature. 2001. IUCN red list categories and criteria, version 3.1. IUCN Species Survival Commission: Gland, Switzerland & Cambridge, UK.

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

Koch, A., M. Gaulke and W. Böhme. 2010. Unravelling the underestimated diversity of Philippine water monitor lizards (Squamata: *Varanus salvator* complex), with the description of two new species and a new subspecies. Zootaxa 2446: 1-54.

Lenk, P., B. Eidenmüller, H. Staudter, R. Wicker and M. Wink. 2005. A parthenogenetic *Varanus*. Amphibia-Reptilia 26: 507-514.

Mertens, R. 1942. Die Familie der Warane (Varanidae). Erster Teil: Allgemeines. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 462, 465, 466: 1-391.

Watts, P. C., K.R., Buley, S. Sanderson, W. Boardman, C. Ciofi and R. Gibson. 2006. Parthenogenesis in Komodo dragons. Nature 444: 1021-1022.

Weijola, V. S.-A. and S.S. Sweet. 2010. A new melanistic species of monitor lizard (Reptilia: Squamata: Varanidae) from Sanana Island, Indonesia. Zootaxa 2434: 17-32.

Welton, L. J., C.D. Siler, D. Bennett, A. Diesmos, M.R., R. Dugay, E.L.B. Rico, M.V. Weerd and R.M. Brown. 2010. A spectacular new Philippine monitor lizard reveals a hidden biogeographic boundary and a novel flagship species for conservation. Biology Letters. doi:10.1098/rsbl.2010.0119

Contact:

ANDRÉ KOCH

Zoologisches Forschungsmuseum A. Koenig &
Leibniz Institute for terrestrial Biodiversity
Department of Herpetology
Adenauerallee 160, D-53113 Bonn, Germany
E-mail: andrepascalkoch@web.de

RECENT PUBLICATIONS

Böhme, W. and A. Koch. 2010. On the type selection and re-typification of two monitor lizard taxa (Squamata: Varanidae): *Monitor bivittatus celebensis* Schlegel, 1844 and *Monitor kordensis* Meyer, 1874; with some comments and corrections on other name-bearing type specimens. Zootaxa 2440: 60-68.

Cunningham, P.L. 2010. Checklist of terrestrial reptiles in three protected areas in the Kingdom of Saudi Arabia. Herpetological Review 41(1): 25-28.

Niekisch, M. 2010. Very early photographs of reptiles. Herpetological Review 41(1): 50-51.

Xu, Z.-Q., Y.-H. Yuan, Z.-B. Chen, W. Zheng, J. Chen, W.-C. Wu and Y.-X. Shen. 2010. Some reproductive characteristics of *Varanus bengalensis* in captivity. Sichuan Journal of Zoology 2010(1): 70-72.

Frydlova, P. and D. Frynta. 2010. A test of Rensch's rule in varanid lizards. Biological Journal of the Linnean Society 100(2): 293-306.

Gramentz, D. 2010. Zur Wahl des Ruheplatzes von *Varanus salvator* (Laurenti, 1768) an einem Flussufer in Sri Lanka. Sauria 32: 55-58.

Hughes-Hanks, J.M., S.K. Schommer, W.J. Mitchell, and D.P. Shaw. Hepatitis and enteritis caused by a novel herpesvirus in two monitor lizards (*Varanus* spp.). Journal of Veterinary Diagnosis and Investigation 22(2): 295-299.

Koch, A., M. Gaulke and W. Böhme. 2010. Unravelling the underestimated diversity of Philippine water monitor lizards (Squamata: *Varanus salvator* complex), with the description of two new species and a new subspecies. Zootaxa 2446: 1-54.

Jones, H.I. 2010. Dwarf monitor lizards (Varanidae: *Varanus*, *Odatria* s. gen.) as definitive and paratenic hosts for physalopteran nematodes. Australian Journal of Zoology 58(2): 69-75.

Mauldin, R.E. and P.J. Savarie. 2010. Acetaminophen as an oral toxicant for Nile monitor lizards (*Varanus niloticus*) and Burmese pythons (*Python molurus bivittatus*). Wildlife Research 37(3): 215-222.

Nijman, V. 2010. An overview of international wildlife trade from Southeast Asia. Biodiversity and Conservation 19: 1101-1114.

Ficetola, G.F., A. Crotini, M. Casiraghi and E. Padoa-Schioppa. 2010. New data on amphibians and reptiles of the northern areas of Pakistan: distribution, genetic variability and conservation issues. North-Western Journal of Zoology 6(1): 1-12.

Pare, J. and A. Lentini. 2010. Reptile geriatrics. Veterinary Clinics of North America: Exotic Animal Practices 13(1): 15-25.

Spennemann, D. 2010. Battle of the big lizards. Reptiles 18(6): 52-53.

Sprackland, R.G. 2010. True blue: care for the rare and challenging blue-spotted monitor. Reptiles 18(7): 32-41.

Weijola, V.S.-A. and S.S. Sweet. 2010. A new melanistic species of monitor lizard (Reptilia: Squamata: Varanidae) from Sanana Island, Indonesia. Zootaxa 2434: 17-32.

Williams, N. 2010. Dragon surprise. Current Biology 20(8): R340.