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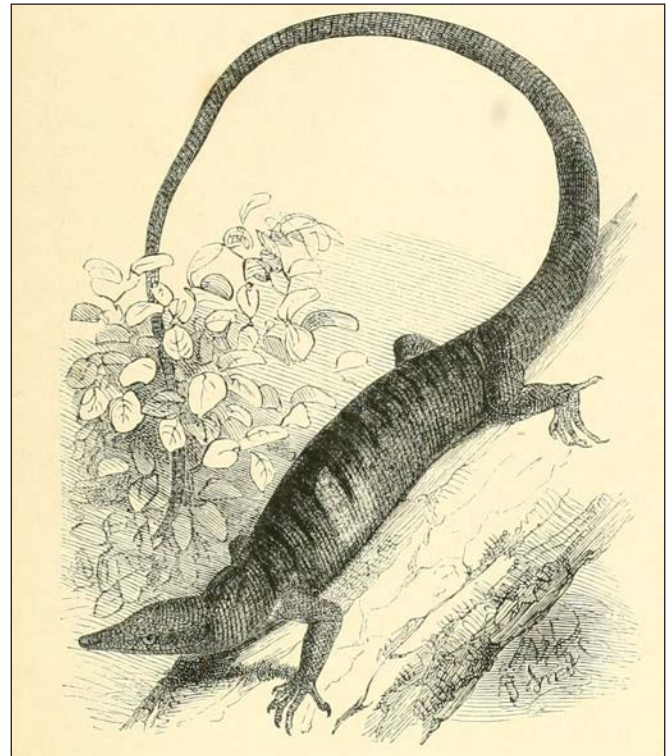
On the Cover: *Varanus prasinus*

The lithographic plate depicted on the cover and inset (right) of this issue represents the first full-body illustration of *Varanus prasinus*, included in Hermann Schlegel and Salomon Müller's 1839 section on Zoology in Coenraad Jacob Temminck's *Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche Overzeesche Bezittingen* (= Transactions on the Natural History of the Netherlands' Overseas Possessions). Originally described by Schlegel in 1839 as *Monitor prasinus*, the species was later grouped together with all monitor lizards in the monotypic genus *Varanus*.

Varanus prasinus is indigenous to New Guinea, several offshore islands and possibly northern Australia, and is part of a larger species complex currently comprising nine morphologically and ecologically similar arboreal species: *V. beccarii*, *V. bogerti*, *V. boehmei*, *V. keithhornei*, *V. kordensis*, *V. macraei*, *V. prasinus* and *V. reisingeri* and *V. telenesetes*. Particularly fascinating is the evolution and origin of body coloration within this group, with each species exhibiting its own unique coloration and patterning ranging from emerald green (*V. prasinus*) to olive green (*V. kordensis*) to black (*V. beccarii* & *V. bogerti*), to blue (*V. macraei*), to black with lighter speckling (*V. boehmei* & *V. keithhornei*), and yellow (*V. reisingeri*).

In addition to generating much interest among herpetological taxonomists and systematists, *V. prasinus* and its kin are popular in captivity, where they have been maintained and bred in both zoos and private collections. A bibliography of published literature on members of this group in captivity is presented in this issue (p. 58).

Varanus prasinus. From: Schlegel & Whitkamp's (1872) *De Kruipende Dieren, Reptilia*.



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

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A hatchling heath monitor, *Varanus rosenbergi*, checks the air temperature and looks around for predators before emerging from its nest. Once away from the termite mound its brilliant colouration will, surprisingly, provide excellent camouflage, for the leaf litter of the surrounding bush is peppered with bright orange and red leaves. Photographed by **David Kirshner**.

NEWS NOTES

Komodo Dragon Stolen from French Crocodile Farm

A 1.2 m long Komodo dragon (*Varanus komodoensis*) was stolen from the Pierrelatte Crocodile Farm in southeastern France in an event that is assumed to be linked to the illegal trade in exotic animals. The thieves broke through a window in the middle of the night without triggering the facility's alarm. No other animals were stolen in the break-in. The animal had an identifying chip placed under its skin; however, since Komodo dragons can only be traded on the black market, it is unknown if this will assist in its retrieval. It was stated that such an animal may fetch between 15,000 and 20,000 € (ca. US \$22,000). The young dragon was at the facility on loan from Barcelona Zoo.

Source: www.thelocal.fr; 5 November 2015

Claims of Varanid Saliva Diabetes Cure Denounced

The Ministry of Health of the United Arab Emirates (UAE) denounced claims that the saliva of varanid lizards (presumably a reference to *Varanus griseus*) has curative abilities for diabetes. The claim has been made that sitagliptin (brand name Januvia®) is extracted from varanid saliva and when taken, can completely cure diabetic patients within a year. The specific origin of the claim was not stated though it was mentioned that the false information had been spread via social media.

It is likely that the claim originated due to a misunderstanding and confusion of different diabetes medications. Exenatide (brand name Byetta®) is a subcutaneously administered medication belonging to a drug class known as GLP-1 receptor agonists; the function of GLP-1 being to increase insulin secretion. Exenatide is a synthetic form of exendin-4, a hormone found in the saliva of the gila monster (*Heloderma suspectum*), a close relative of varanid lizards. Exendin-4 functions in much the same way as GLP-1 but with a longer half-life and a corresponding therapeutic advantage. Despite the discovery of this hormone in gila monsters, the drug itself

has always been synthetically produced and direct saliva extracts offer no known medical benefits. Sitagliptin (Januvia®) is an oral medication belonging to a related class known as DPP-4 inhibitors. Dipeptidyl peptidase 4 (DPP-4) is an enzyme that inactivates GLP-1; thus the inhibition of DPP-4 likewise leads to increased insulin secretion. Sitagliptin is not produced from an exendin-4 analog and thus has even less of a claim to be derived from lizard saliva than does exenatide.

Source: www.gulfnews.com; 3 August 2015

Researchers Ask for Help in Recording Rosenberg's Monitor Sightings

Researchers are encouraging the public to document any sightings of the rare Rosenberg's monitor (*Varanus rosenbergi*) in South Australia. Habitat loss and fragmentation has led to the species being listed as vulnerable, but they are considered to be particularly threatened in the Hills region surrounding the state capital of Adelaide. Researchers stated that the goal for the citizen outreach is to develop an understanding of where the animals are located as well as general population numbers so that a comprehensive survival strategy can be enacted. Researchers emphasized that the animals should not be approached but that a photo should be taken and reported. Sightings should be reported at: <http://www.discoverycircle.org.au/projects/goanna-watch/>

Source: www.abc.net.au; 7 September 2015

Houston Zoo Komodo Dragon Euthanized

Smaug, a 17-year-old male Komodo dragon (*Varanus komodoensis*) at the Houston Zoo (USA) was euthanized following the discovery of severe lumbar spinal cord compression. The condition had left the animal unable

to walk and the decision to euthanize was made after CT and MRI scans revealed its severity. The animal originally came to the zoo in 2001 and had since been a regular feature during enrichment days and other public education events. Last year, Smaug had been successfully treated by a veterinarian team for weakness in his front limbs, though zoo officials say this was unrelated to his recent condition.

Source: www.theexaminer.com; 18 November 2015

Buffalo Zoo to Receive Komodo Dragons

The Buffalo Zoo (USA) is scheduled to undergo an extensive US \$2.5 million renovation of its 73-year-old reptile house. Among the many species that will be added to the collection once renovations are completed is the Komodo dragon (*Varanus komodoensis*). Renovations will begin in 2016, with the new building completed by summer 2017.

Source: www.buffalonews.com; 15 December 2015

Monitor Lizard Blood Sought as Aphrodisiac

In Krishnagiri, India, the Bengal monitor (*Varanus bengalensis*) is being targeted by poachers belonging to the Narikuravas tribal community due to purported aphrodisiacal properties of the species. Individuals of this species are being trapped and hunted with dogs in the forests of Pudukottai, Aranthangi and Palani, and then transported to other parts of the state for sale. The purported aphrodisiacal effects are believed to come through the drinking of the lizards' blood, which is prepared in a cocktail with alcohol. Officials plan to target poachers as well as customers who fuel the demand for monitor lizard blood.

Source: www.timesofindia.com; 22 June 2015

Nile Monitors Established in Palm Beach County, Florida

Adding to the known introduced populations of Nile monitor (*Varanus niloticus*) in Florida, USA, a new population has recently become established in Palm Beach County, Florida. In Palm Beach County, the *V. niloticus* presently occur along a 12 mile (19 km) stretch of canals and adjacent waterways running from I-95 west to the Loxahatchee National Wildlife Refuge, where 42 individuals have been retrieved from over the last five years. Wildlife officials plan to increase their targeted searches to four to six times a month, and will be distributing fliers informing and requesting the public to photograph and report any individuals spotted.

Source: www.sun-sentinel.com; 10 April 2015

Keeper Bitten by Komodo dragon

A reptile keeper at Omaha's Henry Doorly Zoo (USA) was bitten on the hand by a juvenile Komodo dragon (*Varanus komodoensis*) while servicing its enclosure. After receiving two stitches and antibiotics, the keeper was released from the hospital and is expected to make a full recovery.

Source: www.omaha.com; 1 June 2015

Denver Zoo Euthanizes Komodo Dragon

Castro, a 21-year-old male Komodo dragon (*Varanus komodoensis*) at the Denver Zoo (USA) was euthanized due to ongoing complications from arthritis. The animal experienced a decline in the mobility of its rear legs over the previous six years, and had been treated with physical therapy, pain medication and acupuncture. Castro was one of the first groups of hatchlings produced in the United States, hatching in 1994 and then later siring two clutches of offspring.

Source: www.denverpost.com; 9 July 2015

Komodo Dragon Given Acupuncture Treatment

An adult female Komodo dragon (*Varanus komodoensis*) at the Palm Beach Zoo (USA) is undergoing acupuncture treatment to help relieve neck and leg pains that are affecting its feeding ability and movements. The animal has also recently undergone a CT scan in an effort to identify the source of the dragon's chronic pain.

Source: www.sun-sentinel.com; 17 November 2015

Annual Meeting of the DGHT-AG Warane und Krustenechsen

16-17 April 2016 - Neunkirchen Zoological Gardens

With the support of the local DGHT group "Saar-Pfalz" the annual meeting of the AG Warane und Krustenechsen (Monitor Lizard and Heloderm Working Group) will take place at the Neunkirchen Zoological Gardens in Neunkirchen, southwestern Germany. All talks will be in German. The schedule for the meeting is listed

below. The meeting is open to anybody interested in monitor lizards and Helodermas.

Attendees arriving on Friday may participate in the monthly meeting of the regional DGHT group with a talk by Dennis Fischer (Darmstadt) entitled, "Goanna Land – Field Observations of Australian monitor Lizards".

Day 1: Saturday, 16 April 2016

- 10:00 Reception: Thomas Hörenberg
- 10:30 Daniel Spohn (Homburg/Saar): "Heloderma, the somewhat different lizards"
- 12:00 Lunch break at the Zoo Restaurant
- 13:30 Niklaus Peyer (Ottenbach, Schweiz): "Keeping and first breeding of *Varanus reisingeri* in Switzerland"

- 14:30 Members Meeting
- 14:45 Uwe Krebs (Ansbach): "The feeding process in monitor lizards: On the relevance of observations by reptile keepers for ethology and ecology with a subsequent short movie demonstrating the feeding of crabs and mice by *Varanus dumerilii*"
- 15:30 Coffee Brake
- 15:45 Thomas Schaub (Kappel, Schweiz): "A habitat for animals and plants"
- 16:45 End of talks
- 18:30 Conference Dinner at the Pizzeria Da Antonietta

Day 2: Sunday, 17 April 2016

- 09:30 Guided tour through the reptile facilities of the Neunkircher Zoological Gardens with Christian Andres (Head of Marketing, PR, and Zoo Pedagogics)
- 11:30 End of Conference

Location of the meeting:

Neunkircher Zoologischer Garten gGmbH
Zoostraße 25
,66538 Neunkirchen

Recommended Accommodation:

Hotel am Zoo (www.hotelamzoo.de)
Zoostraße 29
66538 Neunkirchen



Varanus niloticus and weaver bird. Queen Elizabeth National Park, Uganda. Photographed by **David Bygott**.

ARTICLES

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Historical Notes on a Living Specimen of *Lanthanotus borneensis* (Squamata: Sauria: Lanthanotidae) Maintained at the Bronx Zoo from 1968 to 1976

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Abstract – Until very recently, the Bornean earless monitor, *Lanthanotus borneensis*, has rarely been kept in captivity, and published accounts on the habits of captive individuals and their husbandry are scarce. In this account, we detail aspects of the husbandry and behavior of a single *L. borneensis* maintained in captivity by the Bronx Zoo from 1968 to 1976, in the hopes that this information may contribute towards an improved understanding of the species' biology and captive management.

Introduction

The Bornean earless monitor, *Lanthanotus borneensis*, remains one of the world's most enigmatic lizards (Fig. 1). Known only from Sarawak, Malaysia and West Kalimantan, Indonesia (Yaap *et al.*, 2012), Pianka (2004) estimated that only around 100 specimens of the species had ever been collected. Although several museum-based investigations have focused on its morphology and systematics (McDowell & Bogert,

1954; Underwood, 1957; Olivier, 1980, 1992; Maisano *et al.*, 2002), field studies have been lacking, and basic information on its natural history and occurrence remains scarce (Mertens, 1966; Proud, 1978; Harrisson, 1961; Harrisson, 1961, 1965; Harrisson & Haile, 1961; Das, 2003; Auliya, 2006; Yaap *et al.*, 2012). From limited encounters with the species in the wild, it is believed to be nocturnal (Das, 2003), and has been collected in both

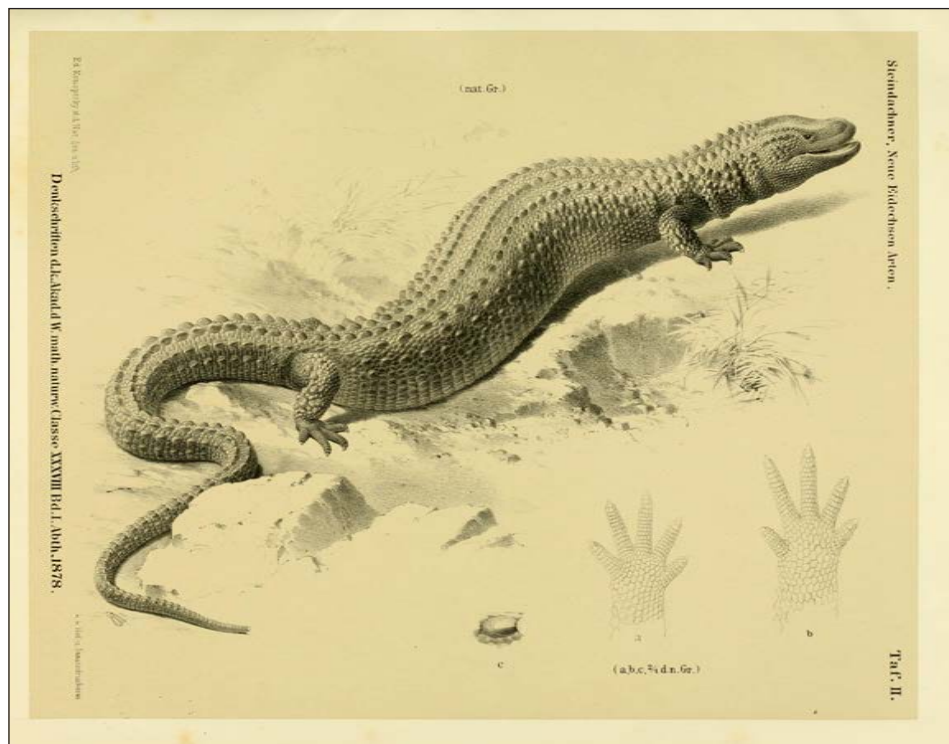


Fig. 1. *Lanthanotus borneensis*.
From Steindachner, 1877.

terrestrial and aquatic environments (e.g., Harrisson & Haile, 1961; Pianka, 2004; Yaap *et al.*, 2012).

While captive observations can yield valuable information about the biology of poorly studied reptile taxa such as *L. borneensis*, until very recently, there have been few records of the species in captivity. Harrisson (1961, 1962) and Harrisson (1963, 1966) maintained several specimens temporarily in Sarawak before sending them to various collections abroad. German herpetologist Robert Mertens acquired four specimens from Harrisson in 1963, of which one lived for several years in his collection (Mertens, 1964, 1966, 1970a,b). In North America, the species has been kept by the Bronx, Cincinnati and San Diego Zoos (Shaw, 1963; Murphy, 2007, 2015), and Sprackland (1999) noted that some living specimens became available in the North American reptile trade in the mid- to late-1990s.

After nearly two decades of absence from zoos and private collections, *L. borneensis* recently reappeared in the international reptile trade in 2012. Despite export restrictions from its range countries of Malaysia and Indonesia, and efforts to list the species under Appendix I of the Convention on International Trade in Endangered Species (CITES, 2015), numerous specimens have been illegally exported to Japan, Europe and the United States, and are now held in private collections (Nijman &

Stoner, 2014). Additionally, according to the Zoological Information Management System (ISIS, 2015), *L. borneensis* is currently kept by the Budapest Zoo and Botanical Garden (Hungary). Although several claims of captive breeding have been reported for this species from Europe, most of these remain dubious and have yet to be verified. To date, the only confirmed, documented case of successful captive reproduction of the species occurred at a Japanese reptile zoo in 2014 (Shirawa & Bacchini, 2015).

Given the dearth of information available on *L. borneensis*, additional reports on specimens maintained in captivity can provide valuable information on the habits, behavior and husbandry of the species. The following article reflects on a single *L. borneensis* of unknown gender maintained by the herpetology department of the Bronx Zoo (New York, USA) between 1968 and 1976. Collected from Simunjan District, 3rd Division, Sarawak, Malaysia and gifted to the zoo by the Sarawak Museum in November 1968, few published accounts of this specimen exist, with only brief references to its longevity (Bowler, 1977) and diet (Bellairs, 1972). From archived husbandry records and miscellaneous notes, we present information pertaining to this specimen's husbandry, behavior, and growth in the hopes that it may offer some additional insight

into what is currently known about this poorly studied species. Although an earlier specimen of *L. borneensis* was received by the Bronx Zoo from the Sarawak Museum in September 1961 (Harrisson, 1961, 1962), records of this animal and its husbandry at the zoo could not be located. This specimen was purported to have survived for only a few months and was later deposited in the herpetology division of the American Museum of Natural History (AMNH R-87375, fluid-preserved).

Results and Observations

Husbandry

Housing comprised a glass terrarium measuring 76 x 30 x 38 cm (l x w x h) with the rear and side walls painted green, the front covered with cardboard, and the screen top covered with black cloth to reduce light intensity. The floor was divided into three sections consisting of an area of sand, an area of mulch, and a water basin. A rock and a log provided refuge and completed the furnishings. A heat lamp was later added in January 1969 which maintained ambient temperatures within the terrarium around 21.1° C.

Diet

The specimen accepted many different prey items including squid, pieces of flounder, sardine and anchovy, live goldfish and earthworms, but refused mussel feet, frog legs and bird eggs. Prey items were offered once to five times weekly.

Parasites

Nothing is currently known about the parasites of *L. borneensis* (Pianka, 2004). In October 1969, the specimen tested positive for hookworms (taxon not identified); however, since the animal had been in captivity for almost a year, it is unknown whether this represented a lasting wild infection or one that originated in captivity from another species in the collection.

Behavior

Unlike many of the varanid lizards kept by the Bronx Zoo at the time, the *L. borneensis* was rarely seen active, spending most of its time burrowed beneath the substrate in its enclosure or submerged in its water basin. Feeding occurred exclusively at night; therefore, observations of actual foraging and feeding behavior

were limited. When foraging, however, the lizard did employ its tongue for scent detection in a fashion similar to varanids and helodermatids. Of particular interest, husbandry records indicate that aquatic prey was occasionally swallowed while underwater, although no further details about this behavior were recorded.

Growth and Death

At the time of its acquisition, the specimen measured 38.2 cm in total length (TL) and weighed 83.5 g. The last measurements recorded prior to its death were a TL of 47 cm and mass of 209.3 g, indicating a 23% increase in body length and a 150.7% increase in mass over a period of nearly eight years. Interestingly, body mass fluctuated considerably, although gradually increasing over time.

Upon its death in September 1976, the animal was donated to the American Museum of Natural History (AMNH R-113983, fluid-preserved). Examination of this specimen by RWM in 2009 revealed that the animal was noticeably obese (Figs. 2-4), particularly in the neck region, when compared to photographs and illustrations of wild individuals (*e.g.*, Harrisson & Haile, 1961; Harrisson, 1965; Pianka, 2004; Yapp *et al.*, 2012) and recently imported wild-caught specimens observed in the pet trade. It is doubtful that this appearance is the result of fixation or preservation, especially considering that obesity is common among closely related taxa in captivity, particularly varanids and helodermatids.

Discussion

The *L. borneensis* described in this account and the specimen maintained by Robert Mertens for more than 7.5 years (Mertens, 1970a) represent the longest-living captive specimens hitherto documented for the species. Of the relatively few individuals that have been maintained in captive collections and reported on, most have fared poorly and did not live long (Harrisson, 1965; Mertens, 1964, 1966, 1971). Surprisingly, these two specimens lived for many years during a period when the biology and captive husbandry requirements of many reptiles were still poorly understood and captive lifespans were typically short.

The observed reclusiveness and cryptic nocturnal behavior of the *L. borneensis* at the Bronx Zoo is consistent with other reports on the species' activity and behavior in captivity (*e.g.*, Anonymous, 1973; Harrisson, 1961, 1962; Harrisson, 1966; Harrisson & Haile, 1961; Mertens, 1966; Proud, 1978; Shirawa & Bacchini, 2015), and corroborate previous claims that



Figs. 2-4. Former *Lanthanotus borneensis* maintained at the Bronx Zoo; now in the collection of the American Museum of Natural History (AMNH R-113983, fluid-preserved). Photographed by **Robert W. Mendyk**.

it is semi-aquatic and nocturnal in the wild (Das, 2003). Earthworms and fish appear to be regularly accepted by most captives (Mertens, 1966, 1970; Murphy, 2015; Shaw, 1963; Shirawa & Bacchini, 2015; this study).

The apparent ability of *L. borneensis* to swallow prey while fully-submerged (Shirawa & Bacchini, 2015; this study) is intriguing, as this behavior has rarely been documented in lizards (*i.e.*, *Amblyrhynchus cristatus*). While many varanid lizards, the sister group to *Lanthanotus* (Ast, 2001), are highly-adept at capturing aquatic prey, they must return to the surface or land to swallow their prey (*e.g.*, Cota & Sommerlad, 2013; Shannon & Mendyk, 2009; Shuter, 2014); a possible exception is the highly aquatic *V. mertensi*, which has been reported to swallow prey underwater (S. Sweet, pers. comm.). Investigations of the anatomical features that enable *L. borneensis* to swallow prey underwater as well as observations on its foraging and prey handling tactics in captivity can shed further light on this unusual ability.

Acknowledgments - We wish to thank Bill Holmstrom for sharing his thoughts and recollections on this specimen, the American Museum of Natural History for allowing access to the preserved specimen, André Koch, David Dickey and Robert Sprackland for providing useful information and literature, Dee McAloose for reviewing pathology records for this individual, and the Wildlife Conservation Society's Bronx Zoo for their support.

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International Trade in the Blue Tree Monitor Lizard *Varanus macraei*

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Abstract - Using Convention on International Trade in Endangered Species (CITES) trade statistics derived from the CITES Trade Database (UNEP World Conservation Monitoring Centre, Cambridge, UK), published literature and anecdotal information from the internet, the wildlife trade in *Varanus macraei* is described. The lizard is a high value pet commodity and although it is traded in relatively small numbers, virtually all trade appears to be of animals harvested directly from the wild population on Batanta Island, Indonesia. Export data suggests an extraction rate of over 6.6 individuals per km² over a decade, with a total value of between US \$1-2 million. Trade to some countries including Russia, Taiwan and Ukraine is underestimated or omitted by import data. Overall trade in the species is increasing and prices have remained high despite captive breeding events in Europe and the United States, with captive bred animals representing less than 1% of worldwide trade.

Introduction

Varanus macraei is a very attractive tree monitor species closely related to *V. prasinus*. It was formally described in 2001 from animals in the wildlife trade and named after a reptile dealer (Böhme & Jacobs, 2001). Trade in the species was first reported by the Convention on International Trade in Endangered Species (CITES) in 2003. The species appears to occur only on the Indonesian island of Batanta and some offshore islets, with a total area of less than 430 km², but no data on the wild population of *V. macraei* exists. Two searches for the species over 2-4 days both caught single animals (Del Canto, 2013; Reisinger, 2014). Del Canto (2013) was told by a local guide that *V. macraei* had been extirpated from an (unidentified) offshore islet as a result of pet trade collection.

Previous analysis of the trade in *V. macraei* estimated 631 animals traded between 2003 and 2005, but relied exclusively on import reports from CITES comparative tabulations, on the basis that export data overestimates trade because it includes permits which were issued but may not have been used (Pernetta,

2009). However, discussions at the inaugural meeting of the IUCN Monitor Lizard Specialist Group in 2015 suggested that *V. macraei* was present in the wildlife trade of some countries for which no import data existed. The aim of this work is to summarize data on trade in the species up to 2012/2013 using CITES data and additional information available online.

Methods

CITES comparative tabulations (downloaded 1 December 2015) were used for analyses, which include data from Indonesia up to 2012 and some other countries up to 2013. Annual numbers of transactions in *V. macraei* were calculated from CITES comparative tabulations, using each row as a single transaction. Matched transactions were rows that included figures from both exporting and importing countries. For data analysis, averages are expressed as mean + s.d.

To look at trends in retail prices of *V. macraei*, prices were taken from 32 for sale advertisements

from the USA posted on faunaclassifieds.com between 2003 and 2014 (A, Appendix 1). Four advertisements posted online from Europe between 28 November and 4 December 2015 were used to estimate current values (B-E, Appendix 1).

“Cursory internet searches” were performed using the Google search engine accessed from the United Kingdom, with data filtered according to date where appropriate. To look for evidence of the presence of *V. macraei* in countries that have not recorded imports, cursory searches on Google were performed using the terms “*Varanus macraei*” or “blue tree monitor” together with names of countries. Internet searches were conducted for a total of 100 minutes.

Results

Seven countries have reported exports and 25 countries have reported imports of *V. macraei*. All transactions were of live animals, except a presumably erroneous entry recording export of two *V. macraei* leather products from Argentina to the United States (excluded from subsequent analyses). Of 165 records for *V. macraei*, three were declared as animals sourced from the wild (CITES code W), 49 as captive bred animals (code C) and 111 as farmed (code F). Two seized shipments (code I) were reported; a single animal exported from New Zealand to Indonesia (excluded from analysis) and five animals exported from Indonesia to the United States.

Trade from Indonesia

Indonesia is the largest exporter of *V. macraei*. Between 2003 and 2012, Indonesia reported exports of 2,847 *V. macraei* to 22 countries. Between 2003 and 2013, 12 countries reported imports of 1,562 *V. macraei* from Indonesia (Figs. 1 & 2; Table 1). One country (South Africa) not included in Indonesian export records reported import of the species from Indonesia.

The number of countries reporting imports from Indonesia remained stable between 2006 and 2013 with a mean of 6.5 ± 1.07 countries per year. The number of countries reported as importers by Indonesia increased between 2006 and 2012 with a mean of 13.5 ± 7.43 per year.

The number of recorded transactions in *V. macraei* from Indonesia shows an upward trend from all sources (Fig. 3). An average of 7.6 ± 3.01 transactions per year were recorded from 2003-2013 by importing countries and an average of 10.8 ± 5.16 transactions per year by

Indonesia. The number of matched transactions showed no overall trend (Fig. 4), with an average of 42.4 ± 19.5 % matched transactions per year.

Ten of 16 countries with recorded trade in less than 50 *V. macraei* did not report any imports of the species (Table 1). Indonesia reported export of 218 lizards to those countries up to 2012. South Africa reported import of six *V. macraei* from Indonesia in 2009, although Indonesia did not report any exports of the species to South Africa.

Exports of Varanus macraei from countries other than Indonesia

Exports from countries other than Indonesia accounted for 34 animals in import reports and 61 animals in export reports (Table 2). Seventeen imported and 21 exported animals were not declared as being of Indonesian origin, representing 0.9% and 0.7% of total international trade.

Value of trade in V. macraei

The average price per individual of animals offered for sale between 2003 and 2014 was US \$736 \pm 234 (range \$475-1500) (Fig. 14). Animals described as “juvenile” or “young” tended to be more expensive than animals described as adult. The dataset is too small to show clear trends but suggests that the price of the animals has remained more-or-less constant.

Advertisements posted online between 28 November and 4 December 2015 indicate a current average price of *V. macraei* in Europe of €930 \pm 128.8 (range €800-1,000), equivalent to approximately US \$1,087 \pm 141.3 (range \$878-1207).

Evidence of trade in V. macraei not recorded in import reports

Records of *V. macraei* in countries that have not declared imports of the species are restricted to Taiwan (Shiau, 2006), Russia (Andreeva *et al.*, 2008) and the Philippines (Sy, 2015). Cursory internet searches found evidence of captive *V. macraei* in three additional countries (Denmark, Sweden and the Netherlands) that have not reported imports of the species (F-J Appendix). There is also evidence that *V. macraei* had been imported into the United Kingdom prior to 2009 and that by 2012 more than three specimens had been kept in the country (K, L Appendix 1). A zoo inventory suggests *V. macraei* is/has been maintained at 33 zoos in 12 countries

Table 1. Summary of trade in *Varanus macraei*.

Country	Importing Country						Indonesia						
	No. Transactions	Period	No. Animals	Average No. Animals per Transaction	No. Transactions	Period	No. Animals	Average No. Animals per Transaction	No. Transactions	Period	No. Animals	Average No. Animals per Transaction	Figure
United States	21	2003-2013	737	35 ± 27.7 (4-115)	12	2003-2012	1462	122 ± 59.0 (38-245)		2003-2012			5
Japan	13	2003-2013	183	14 ± 10.7 (1-37)	13	2003-2012	388	30 ± 19 (3-62)		2003-2012			6
Germany	11	2003-2014	102	9.3 ± 8.0 (1-27)	8	2005-2012	102	12.8 ± 8.3 (5-29)		2005-2012			7
France	10	2003-2013	305	30.5 ± 27.1 (2-82)	8	2003-2012	326	40.8 ± 18.9 (2-64)		2003-2012			8
Czech Republic	14	2003-2014	160	11.4 ± 8.1 (2-32)	7	2003-2012	119	17 ± 15.1 (4-45)		2003-2012			9
Taiwan	-	-	-	-	10	2003-2012	103	10.3 ± 5.9 (3-22)		2003-2012			10
Russia	0	2003-2012	0	-	8	2003-2012	43	5.4 ± 3.5 (2-13)		2003-2012			11
South Korea	5	2003-2013	41	8.2 ± 7.3 (1-20)	5	2003-2012	25	5 ± 3.7 (1-10)		2003-2012			12
Great Britain	1	2003-2013	3	-	5	2003-2012	27	5.4 ± 2.7 (3-10)		2003-2012			13
Switzerland	2	2003-2013	13	6.5 ± 0.7 (6-7)	1	2003-2012	6	-		2003-2012			-
Spain	3	2003-2013	12	4 ± 0.0 (4-4)	6	2003-2012	28	4.6 ± 2.7 (2-10)		2003-2012			-
Malaysia	3	2003-2014	7	2.3 ± 1.2 (1-3)	3	2003-2012	14	4.6 ± 1.5 (3-6)		2003-2012			-
United Arab Emirates	0	2003-2013	0	-	3	2003-2012	47	15.6 ± 12.5 (7-30)		2003-2012			14
Ukraine	0	2003-2010	0	-	2	2003-2012	40	20 ± 14.1 (10-30)		2003-2012			15
Austria	0	2003-2014	0	-	3	2003-2012	17	5.6 ± 2.9 (4-9)		2003-2012			-
Bahrain	-	-	-	-	1	2003-2012	10	-		2003-2012			-
Canada	0	2003-2011	0	-	4	2003-2012	17	4.3 ± 6.1 (1-7)		2003-2012			-
Georgia	0	2003-2014	0	-	1	2003-2012	3	-		2003-2012			-
Oman	0	2008-2012	0	-	1	2003-2012	10	-		2003-2012			-
Pakistan	0	2003-2014	0	-	2	2003-2012	16	8 ± 2.8 (6-10)		2003-2012			-
Slovakia	0	2003-2014	0	-	1	2003-2012	15	-		2003-2012			-
South Africa	1	2003-2012	6	-	0	2003-2012	0	-		2003-2012			-

Table 2. Trade data for *V. macraei* exported from countries other than Indonesia

Exporting Country	Import Quantity	Export Quantity	Importer Transactions	Exporter Transactions
Switzerland	8	16	2	2
Czech Republic	2	2	1	1
Germany	17	26	6	9
Sweden	0	2	0	1
United States	6	15	2	4

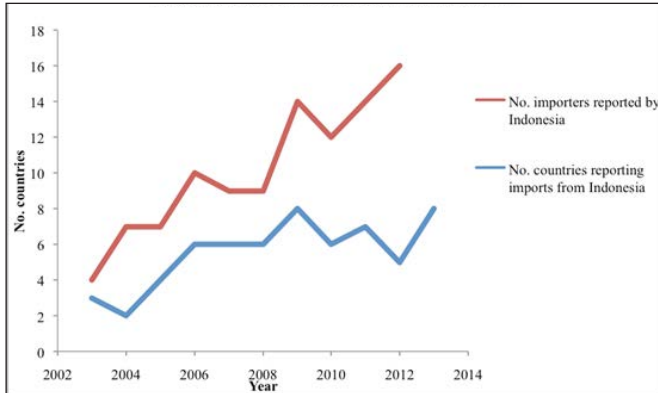


Fig. 1. Number of countries importing *Varanus macraei*.

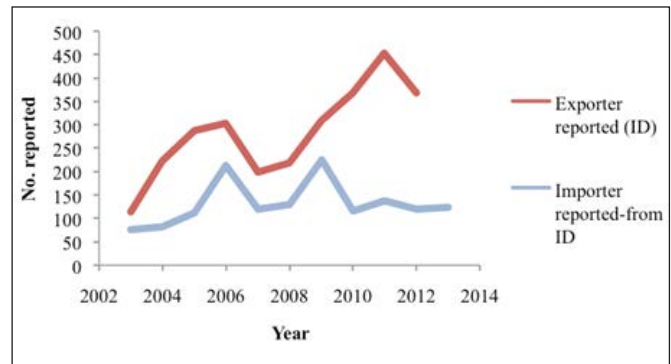


Fig. 2. Trade in *V. macraei* from Indonesia.

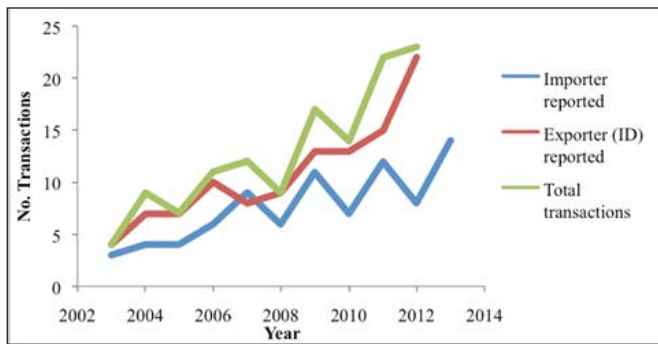


Fig. 3. Number of transactions in *V. macraei* from Indonesia.

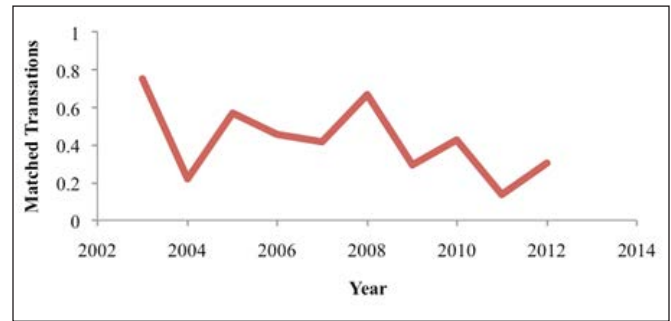


Fig. 4. Proportion of matched transactions in *V. macraei* from Indonesia.

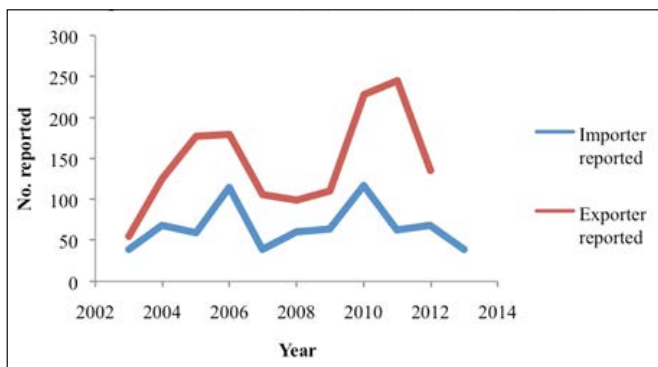


Fig. 5. Exports of *V. macraei* from Indonesia to the United States.

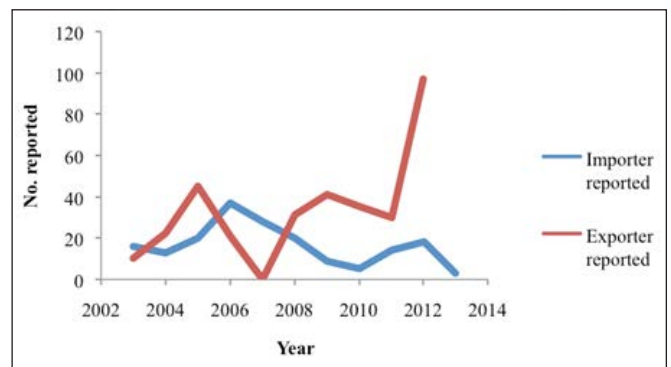


Fig. 6. Exports of *V. macraei* from Indonesia to Japan.

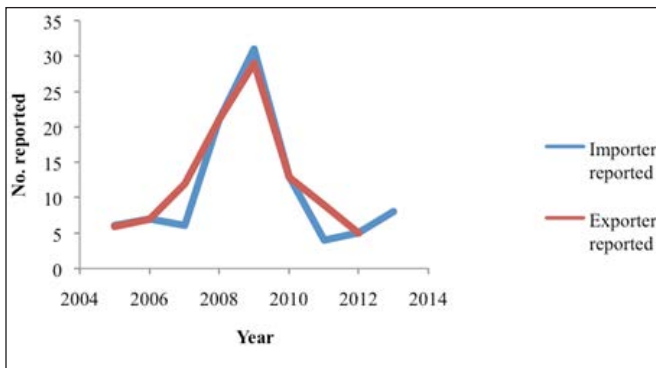


Fig. 7. Exports of *V. macraei* from Indonesia to Germany.

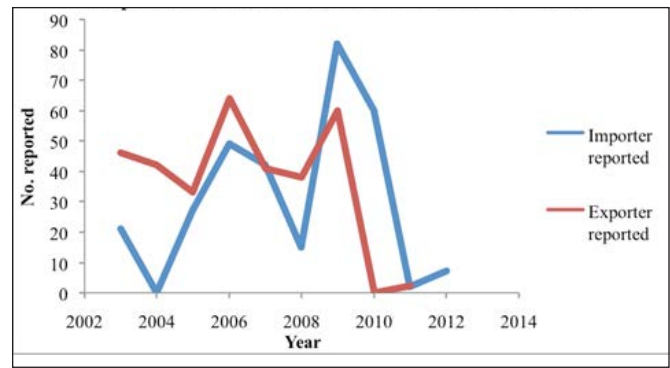


Fig. 8. Exports of *V. macraei* from Indonesia to France.

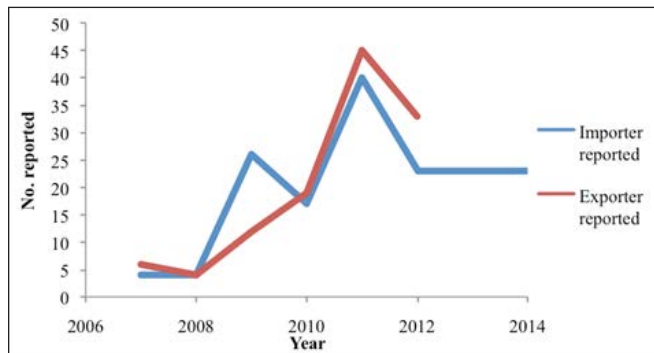


Fig. 9. Exports of *V. macraei* to the Czech Republic.

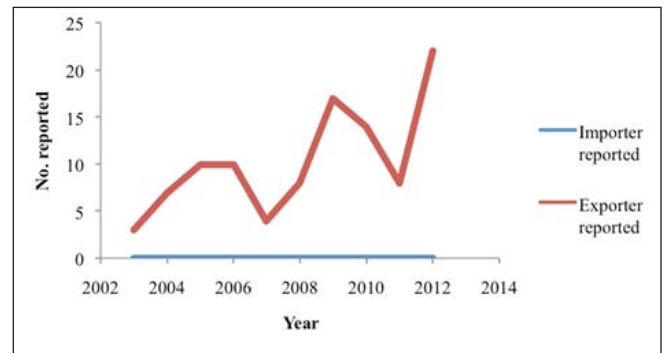


Fig. 10. Exports of *V. macraei* from Indonesia to Taiwan.

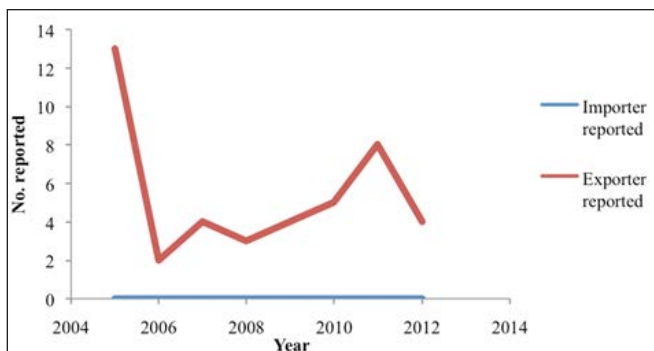


Fig. 11. Exports of *V. macraei* from Indonesia to Russia.

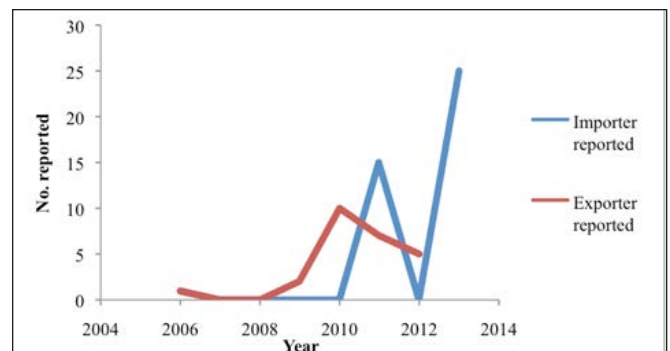


Fig. 12. Exports of *V. macraei* from Indonesia to Korea.

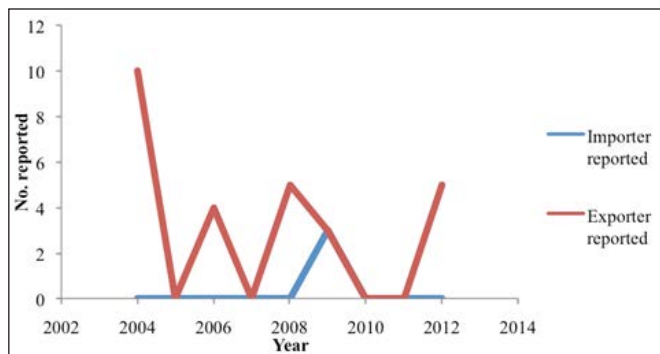


Fig. 13. Exports of *V. macraei* from Indonesia to the United Kindgom.

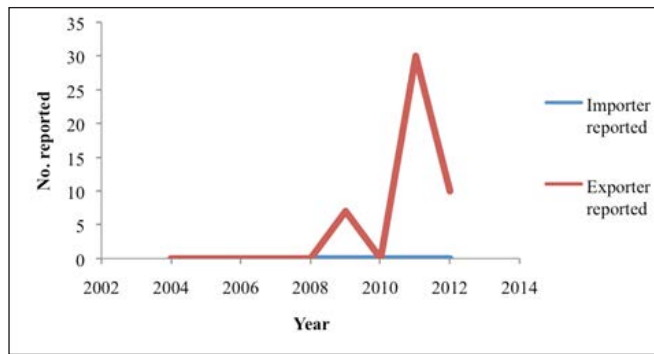


Fig. 14. Exports of *V. macraei* from Indonesia to the United Arab Emirates.

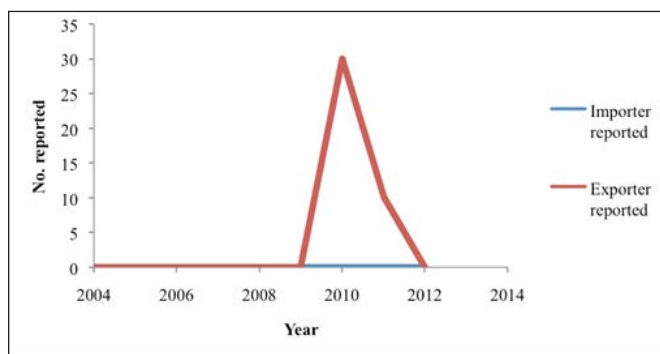


Fig. 15. Exports of *V. macraei* from Indonesia to the Ukraine.

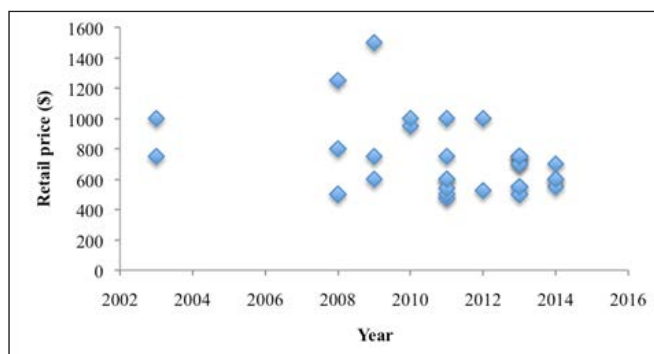


Fig. 16. Price of *V. macraei* in the United States.

including Denmark, Norway, Poland, Russia, Slovakia, Sweden and Ukraine (M). Evidence from social media also suggests a substantial domestic market for live *V. macraei* within Indonesia (N-P).

Evidence of illegal trade in V. macraei

There appears to be no systematic recording of seized animals not accompanied by CITES certification. Ziegler *et al.* (2009) reported on the confiscation of a sub-adult pair of *V. macraei* in the Czech Republic (2004) and another pair in Germany (2007). Hroudova (2004) reported a 2004 attempt to illegally import 112 specimens of reptiles including *V. macraei* into the Czech Republic. A cursory internet search revealed a 2011 seizure of *V. macraei* in Indonesia as part of a shipment in boxes belonging to a Russian national (Q).

Discussion

Trade in *V. macraei* between 2003 and 2005 was described by Pernetta (2009) based on import permits

alone. However, there is evidence of the occurrence of *V. macraei* in countries for which export reports exist but import reports do not. Thus export reports may identify countries where *V. macraei* are traded more accurately than import reports, and in at least some cases may provide more realistic estimates of trade volumes.

All countries for which export reports exist but import reports do not are signatories to CITES except Taiwan. Bahrain did not become a signatory until 2012. Although the Russian Federation has been a member since the country’s formation, no imports of live *Varanus* or products derived from of any varanid species have been reported, despite reported exports of 3,145 live animals and over 58,000 skins and leather products to the country since 2002. The lack of border controls between countries of the European Union means that all *Varanus* species listed under CITES Appendix 2 (“Annex B”) can be traded between EU states without CITES documentation, with the exception of suspensions in some populations including wild caught *V. beccarii* and *V. salvadorii* from Indonesia (European Union, 2015). The lack of a monitoring system within the EU means

that consumer countries cannot be identified.

Both importer- and exporter-reported figures suggest an increasing number of consumer countries and some increase in the overall volume of trade in *V. macraei*. Whilst importer-reported trade suggests minor increases in overall trade volumes since 2005, exporter reports suggest a more substantial increase. The increase is at least partly due to an increase in consumer countries in Asia, some of which fail to record imports of the animals.

There is substantial literature on the captive reproduction of *V. macraei* (e.g., Dedlmar, 2007; Jacobs, 2002; Mendyk, 2007; Moldovan, 2008; Zeigler *et al.*, 2009), and anecdotal online information indicates that the species is bred in captivity with F1 offspring traded internationally. Although it is possible that a small captive bred population of this species has been established, the available evidence suggests that captive reproduction in the species is mainly sporadic and claims of F2 and subsequent generations are rare (Rauhaus *et al.*, 2014). Perhaps most significantly, evidence of captive breeding exists only for animals maintained in Europe and North America, and reports of captive-bred, ranched or “farmed” animals from Indonesia remain unsubstantiated. Because of a lack of evidence of sustainable harvesting methods or captive breeding within Indonesia (Auliya, 2009; Lyons & Natusch, 2011; Natusch & Lyons, 2012; Nijman & Shepherd, 2010), it is likely that all animals originating from Indonesia are harvested from the wild and declared sources (codes C and F) are inaccurate. The importance (or otherwise) of the collection of gravid females in the trade cannot be estimated. The importance of pre-export mortality on overall levels of exploitation cannot be estimated, but is likely to be significant because monitor lizards of the *V. prasinus* group dehydrate easily, are considered more difficult to maintain in captivity than other species, and require specialized care (Mendyk, 2015; Zeigler *et al.*, 2009). Therefore, considerable mortality might be expected between capture and export.

Despite captive breeding efforts, the value of *V. macraei* in the wildlife trade has remained high (at least in Europe and the USA) and levels of trade in the species are demonstrably higher than are indicated by importer reports for some countries. Unless a method of distinguishing animals of captive-bred origin from stock harvested from the wild is introduced, the relative importance of captive bred animals in overall trade will remain difficult to assess.

Varanus macraei is a high value animal traded in relatively small quantities. The very small area

of occupancy of *V. macraei* (< 430 km²) indicates a harvesting rate of 3.6-6.6 individuals per km² through the species' range over about a decade. Using importer and exporter reports, and an average retail price of US \$736 per animal, the total value of declared international trade in *Varanus macraei* from Indonesia is estimated at US \$1.15-2.01 million, or US \$104,000-190,000 per year. In comparison, the total value of trade in *V. exanthematicus* since 2003 is estimated at over US \$10 million (assuming an average price of \$30 per animal, based on 342,654 declared imports).

In the absence of data on population size, and considerable uncertainty and concern over levels of exploitation, the status of *V. macraei* should be considered a very high priority subject for future research, and captive breeding of the species should be encouraged, documented and coordinated.

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Appendix: Internet URLs Cited in the Text

- A <http://www.faunaclassifieds.com/forums/archive/index.php/f-52.html>
- B http://www.terrarium.com/tb/list_classifieds.php?split=20&ftsearch=varanus
- C http://www.mendl.ji.cz/index.php?id_category=50&controller=category
- D <https://drive.google.com/file/d/0B0kJYCKDL1yAbTITNnBldTJHQW8/view>
- E http://www.pythons-boas.de/main.php?sprache=english&id=3&link=Abzugeben&waran_id=87
- F <http://www.captivebredreptileforums.co.uk/monitors-big-small/11659-few-pics-my-monitors-here-denmark.html>
- G http://www.terrarium.com/tb/list_classifieds.php?split=280&category_selection=2&type_selection=1
- H <http://repticzone.com/forums/Monitors/messages/648775.html>
- I <https://www.flickr.com/photos/72616463@N00/4225431145>
- J <http://www.reptileforums.co.uk/forums/lizards/788899-green-blue-yellow-tree-monitors.html>
- K <http://www.captivebredreptileforums.co.uk/monitors-big-small/15047-blue-tree-monitors.html>
- L <http://www.reptileforums.co.uk/forums/tags/varanus%20macraei.html>
- M <http://zooinstitutes.com/zoosrating/animal.asp?name=574>
- N <https://www.facebook.com/groups/varanuslovers/>
- O <https://www.facebook.com/groups/AbiezzartGroups/>
- P <https://www.facebook.com/groups/390352824366203/>
- Q http://www.asean-wen.org/phocadownload/reports_publications/Action_Update_q4_2011.pdf

An Annotated Bibliography of the Captive Husbandry, Breeding, Behavior, Veterinary Management and Trade of Tree Monitor Lizards (*Varanus prasinus* Complex)

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Abstract – Members of the *Varanus prasinus* complex, commonly referred to as tree monitors, have been maintained in captivity since the 1960s. To date, seven of the nine recognized species comprising this group have been kept and reproduced in captivity. This bibliography provides an extensive compilation of published literature referencing this group in captivity, which should prove useful to zoos and private keepers currently keeping or looking to add representatives of this group to their collections, as well as researchers, veterinary personnel, and wildlife officials monitoring their trade and exploitation.

Introduction

There are currently nine recognized species of varanid lizard belonging to the *Varanus prasinus* species complex (Ziegler *et al.*, 2007), although the validity of one taxon, *V. telenesetes*, has recently been called into question (Koch *et al.*, 2014). Commonly referred to as tree monitors, representatives of this group have been known to science since the 19th century, with *V. prasinus* described by Schlegel in 1839, *V. beccarii* described by Doria in 1874 and *V. kordensis* by Meyer in 1874. Yet, unlike several other varanid species such as *V. niloticus*, *V. albigularis*, *V. griseus* and *V. salvator* which were displayed in zoos and kept in private collections throughout the 19th century (*e.g.*, Anonymous, 1883), it wasn't until the 1960s that living specimens of this group were first maintained in captivity. This absence of *V. prasinus* complex animals from living collections

was most likely due to a combination of factors, including their remote geographical origins within Indo-Australia, their difficulty to locate and collect in the wild, and the lack of a trade network or supply chain of live reptiles from this region at the time. Additionally, given their frailty and susceptibility to dehydration (Boyer & Boyer, 1997; Card, 1995; Hartdegen, 1997; Kirschner *et al.*, 1996; Salisbury, 2010), it is doubtful that living representatives would have survived the long oceanic transport from their home range to Europe or North America during the 19th and first half of the 20th century.

The earliest known representative to be kept in captivity was *V. prasinus*, with a single specimen acquired by German herpetologist Robert Mertens in 1960 (Mertens, 1971) that survived for 10 years

(Mertens, 1970). Since then and as additional species belonging to the complex were discovered and described (e.g., Böhme & Jacobs, 2001; Eidenmüller & Wicker, 2005; Jacobs, 2003), a total of seven species have been maintained in zoos and private collections: *V. beccarii*, *V. boehmei*, *V. keithhornei*, *V. kordensis*, *V. macraei*, *V. prasinus* and *V. reisingeri*. All seven of these taxa have successfully been reproduced in captivity, with some species, particularly *V. prasinus* bred to multiple generations (e.g., Baldwin, 2006; Lemm, 2014; Mendyk, 2012). Although the Convention on International Trade in Endangered Species (CITES) reported the export of several *V. bogerti* from Indonesia during the mid-1990s (CITES, 2015), such claims are highly dubious. Instead, it is likely that these individuals were either misidentified or intentionally mislabeled by traders to thwart or circumvent export restrictions and quotas for similar species within the *V. prasinus* complex, especially considering that *V. bogerti* is not indigenous to Indonesia, and its native Papua New Guinea prohibits the export of wildlife.

Published bibliographies on a particular subject or taxonomic group can be an invaluable resource to keepers and institutions seeking to maintain and reproduce reptiles in captivity. Unfamiliarity with literature on the biology, husbandry and veterinary management of a particular species or taxonomic group can prevent keepers from providing optimal conditions needed for their captives to thrive or inhibit the provision of key parameters needed for successful reproduction to occur. A general unfamiliarity with current and historical literature on the biology, keeping and breeding of varanid lizards has been observed among some keepers, including zoos, and may be contributing to some of the issues and challenges experienced with their care and breeding (Mendyk, 2015; Mendyk *et al.*, in press). Several published bibliographies have been compiled for varanid lizards (Bayless, 1996; Kenyon, 1995; Kronen, 1983); however, these accounts, now around two or more decades old, are grossly outdated and require extensive updating.

To date, no such compilation of literature has been presented for the *V. prasinus* complex, a particularly difficult group of varanids to maintain and breed in captivity (e.g., Aucone *et al.*, 2007; Mendyk, 2006). The following bibliography with accompanying annotations provides a compilation of references, organized by species, which pertain to the captive husbandry, breeding, behavior, veterinary management and trade of the *V. prasinus* complex, with the hopes of familiarizing keepers, researchers, veterinarians,

wildlife officials and general enthusiasts with the information presently available on this unique group of varanids. It should be noted that husbandry, breeding and veterinary information presented for one species may be applicable to other species within the complex given their remarkable similarities in size, morphology, ecology and captive requirements.

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Varanus kordensis

Since *V. kordensis* was formerly recognized as a subspecies of *V. prasinus* and frequently synonymized with the latter by keepers, it is possible that older published accounts (e.g., those preceding Jacobs' [2002] elevation of the taxon to specific rank) reporting on *V. prasinus* may actually reference *V. kordensis*, or both *V. prasinus* and *V. kordensis*. The lack of detailed physical descriptions accompanying many of these reports (i.e., differentiating between dorsal ocelli as in *V. kordensis* or transverse dorsal cross bands in *V. prasinus*) renders distinguishing which of the two species are being referenced nearly impossible. Nevertheless, due to their similarities in size, morphology, behavior and husbandry requirements, information presented for one species should in most cases be considered applicable to the other.

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HISTORICAL FACSIMILES

The following article by E.C. Stirling, originally published in 1912, represents the first published account on the natural history, ecology and behavior of *Varanus giganteus*. Likewise, it also represents one of the first truly detailed accounts on the ecology of varanid lizards, reporting field observations and notes made by several Australian naturalists including Francis James Gillen, the eponym of *V. gilleni*. This account also appears to document the first known living representatives of *V. giganteus* maintained in captivity. Thus, the following article is an important contribution to the biology of this species as well as to the history of varanid lizards in captivity.

-RWM

Stirling, E.C. 1912. Observations on the habits of the large Central Australian monitor (*Varanus giganteus*), with a note on the "fat bodies" of this species. Transactions and Proceedings of the Royal Society of South Australia 36: 26-33.

Observations on the Habits of the Large Central Australian Monitor (*Varanus giganteus*), with a Note on the "Fat Bodies" of this Species

By E. C. STIRLING M.D., Sc.D., F.R.S. [Read June 13, 1912]

As the opportunity of observing, at close quarters, the large Central Australian Monitor lizard, *Varanus giganteus* - and for that matter the same may be said of many other of our native fauna - does not often occur, I have thought that a few notes respecting some of their habits may not be without interest to members of the Society.

By the kindness of Mr. G.K. Grant Warren, of Balariung, William Creek, the National Museum received on February 9 of this year two living specimens of this species, both males, as was subsequently ascertained by dissection. Unfortunately by the misapplication of terms which is so common in Australia, the name "goanna" is commonly applied to this, as well as to some other species of Australian Varanidae, the word being generally understood to be a corruption of iguana, which properly belongs to quite a different group of lizards that is unrepresented in Australia. The origin of the name Monitor, which constitutes the vernacular designation of the Varanidae, is peculiar. The native

name of the Egyptian representative of this group is "ouaran," which is the Arabic term for lizards in general; this word written as 'waran' has been confused with the German "Warnen," to warn, hence these reptiles have been called Warn-eidechsen, or warning lizards, and it is this erroneously derived idea of warning, or admonition, which has found expression in the Latin term Monitor. (1)

The particular species, *Varanus giganteus*, is known locally in regions adjacent to Lake Eyre as "Perentie," or by its variants "Perinthie," or "Parenthie," which words I believe have originated from a native name, though I am not aware of the tribe to which it belongs. Further north, in the MacDonnell Ranges, it is called Echunpa, in the Arunta language, and it gives its names to one of the most important totem divisions of that tribe.

For some time we have been anxious to prepare for the Museum collection some properly-mounted specimens of this reptile, and, with that view, we were glad to have the opportunity of keeping them under

(1) "Royal Natural History", R. Lydekker, Section ix., p. 150.

observation so that we might learn something of their habits and attitudes, of which very little appears to be known. With this view they were placed together in a large wire-netted cage, about 10 ft. long by 4 ft. wide by 3 ft. high, which gave them plenty of room to move about.

Though, from what can be gleaned from books, there appears to be a general similarity as to habits in all the members of this well-marked and widely-spread group, I could find but the scantiest references to this Australian species, and, supplementing our own observations by the results of inquiries made from those who know the animal in its wild state, I am able to offer a few notes of a little-known reptile that may not be without interest. Incidentally our observations have enabled us now to mount specimens in natural attitudes and so to correct various errors into which even the most careful taxidermist can scarcely avoid falling if he has never seen the animal he deals with alive.

In this connection one may express regret that so many reproductions of badly, or unnaturally, mounted specimens, or of inaccurately-drawn plates, have found their way into books of natural history purporting to give true representations of the animals in their natural state. These reproductions, repeated as they so often are from book to book, or serving as models for other mounted specimens, lead to the perpetuation of very erroneous ideas as to the real attitudes and true appearance of the animals in life. It is hoped that the illustrations accompanying this paper, which are reproductions from photographs of the living animals, will, so far as the species is concerned, at least serve as faithful models, either for the taxidermist or zoological artist, of an animal not often observed at close quarters. I think it will also be acknowledged that the Museum taxidermists have in their recently mounted specimens very accurately reproduced some of the unsuspected yet, as it appears, very characteristic attitudes of these reptiles.

The two monitors, received in a perfectly sound and healthy condition, and in process of shedding their skin in patches, were kept under observation in their cage for over three months. From what I had heard of their great voracity and comprehensive tastes in their wild state I anticipated that there would be no difficulty in feeding them, but though eggs, dead and live mice and sparrows, live guinea pigs, and a live rabbit were at different times placed in the cage, they voluntarily ate nothing, and, with the exception to be mentioned directly, they did not attempt to interfere with any of these animals, nor did the latter show any fear of their formidable companions.

Thinking the reptiles might at length be feeling the effects of starvation, and it was evident that they were becoming emaciated and less active, they were on two occasions taken out of their cage and forcibly fed with strips of raw meat—a matter of some little difficulty in the case of the larger specimen on account of his size and strength. It was after the second of these feedings, when possibly excited by the handling or by the taste of meat, that the larger reptile seized the live rabbit, then in the cage, by the loins, holding on to it with a bulldog grip that was never changed or relaxed until the victim died. But it made no attempt to eat the rabbit, though this was left dead in the cage for two days. The guinea pigs used to run over the reptiles, sometimes even perching on their heads in the most confiding way.

The result of this abstinence from food was a progressive emaciation and dwindling vigour, though on being excited they showed themselves still capable of powerful and active movements. Even at the end of the starvation period of three months the larger specimen still retained, as was shown by dissection, two solid masses of fat weighing a pound each. These will be subsequently described.

In their wild state, Mr. Warren informs me, the Perentie is practically omnivorous as regards flesh foods, its diet mainly consisting of other lizards, snakes, birds, eggs, the smaller animals, and, of late years, the rabbit, the only animal of small size that is immune to its attacks being the echidna. The late Mr. Gillen told me he saw one catch and kill a one-third grown kangaroo, and then, placing his forefeet on the body, it tore out pieces of flesh like a dog.

Everyone that has seen these reptiles in their wild state testifies to the extraordinary pace with which they can travel over the ground, and that agility was still manifest in our specimens under the limitations of their cage. In this, when moving quickly, their gait was distinctly quadrupedal, the body, head, and tail being raised some inches above the ground, but, I am informed by Mr. P. Barbe Ayliffe, that when travelling at their topmost speed the forelimbs are raised from the ground, so that their gait then becomes bipedal. We had, however, no opportunity of observing this under the restricted space in which our specimens were confined. I have myself seen this mode of progression, which recalls that attributed to some of the extinct dinosaurs, to take place in the Frilled Lizard (*Chlamydosa, urus kingii*), and it has also been noticed by Mr. J. Rau, one of our taxidermists, in the case of *Amphibolurus cristatus* under extreme speed. It is probable, I think, that closer observation would show a similar mode of progression

for other of the more swiftly moving lizards.

One feature of the Perentie became immediately apparent, *viz.*, the habitual use of the long and muscular tail as a weapon of offence. Whenever the animals became excited either by the suspicious movements of one another, or by being touched by a rod, or even by the too close presence of spectators, most vigorous blows that resounded against the sides of the cage were struck with this organ. The striking of the blow could generally be anticipated by the preparatory attitude in which the tail was held, that is to say, it was flexed well to one side in a curved position, the muscles being manifestly tense. To prevent any obstruction to the blow the thick proximal part and the end of the tail were held clear of the ground so that it touched only by a limited length of its middle portion. Mr. Gillen, who was well acquainted with these animals, informed me that he once saw a large Perentie knock down a native woman in this way by a blow on the legs, and Mr. Warren writes that he had known both forelegs of a dog to be broken in a similar manner. No one who has seen the force of these blows could have any difficulty in accepting such statements.

This offensive use of the tail is described (2) in the case of *Varanus salvator*, apparently the largest member of this group, which inhabits Ceylon, the Malay Peninsula, and the islands of the Malay Archipelago, and extends, according to the British Museum Catalogue of Lizards (1885), to the Cape York Peninsula of Queensland, but I have not seen the habit noticed in the case of *Varanus giganteus*. It is, however, not unlikely a common feature of the larger members of the group. When alarmed the Perenties have a habit of running up tree in their efforts to escape, which they do with extraordinary swiftness; they have been known, also, to run up a man or a horse, probably, in their alarm, mistaking these vertical objects for trees. On one occasion, at Alice Springs, Mr. Gillen treated the lacerated breasts of a lubra who had been attacked by one, and, according to this informant, the blacks, who have a fear of these animals, state that such attacks were not uncommon. It may be, however, that the attacks are not deliberate, but that in their alarm and desire to escape they run up the first vertical object that presents itself, under which circumstances wounds would not unlikely result from the very sharp and strong claws or even from the teeth.

Notwithstanding the fear of the natives for these

reptiles their flesh is esteemed a great delicacy, and it is no doubt in consequence of the appreciation of it by the adults that it is one of the foods (which, it may be observed, are generally of some gastronomic merit) that are forbidden to uninitiated boys of the tribe. (3) I have also heard white men speak approvingly of the flesh of the tail of the Perentie, though in the case of one man who had often tried he stated that it always induced vomiting.

The aspect of the head and neck is very snakelike, and it was noticed that in moving amongst the branches of a dead limb placed in the cage in imitation of a small tree that the Perentie was able, while holding on by the grasp of its hind limbs only and by utilizing the tail as a lever, to project the rest of the unsupported body into space while seeking for a hold for the fore paws.

When excited or provoked they utter a sound which may be described as a combination of a hiss and of a continuous blowing sound like that of a blacksmith's bellows, and under these circumstances of provocation the throat is inflated into a large and conspicuous pouch, often to a more considerable degree than is shown in pl. iv., figs. 1 and 2; the long-forked tongue is also protruded and withdrawn with lightning-like rapidity.

They are stated to be capable of being readily tamed, and I have been told of one that used to appear regularly at stated times to be fed and to follow its adopted master about.

In their native habitat they usually live in holes in the ground, and, according to Mr. Warren, they prefer a hole that enters under a rock to one in the open ground. In these holes they hibernate from May to August, living sometimes singly and sometimes male and female together.

Distribution.-As is so often the case with many of our Australian animals, we have very little information as to the exact distribution of this species. Many, indeed, of our animals have already become extinct without our having been able to answer this question, and it will probably be the same with many others. Mr. Gillen told me that they occur in Central Australia from about Strangways Springs, in the south, to Hann's Range, about 80 miles north of the MacDonnell Ranges, but as to its range east and west of this tract I have no information. Its favourite habitat being rough, stony country, its distribution is no doubt largely determined by these conditions. The late

(2) "Reptiles of the World", R.L. Ditmars.

(3) Spencer and Gillen, "Native Tribes of Central Australia", p. 471.

Mr. John Bagot used to speak of them as common and of large size on what was, then, his Peake Station, which comprised the country around Warrina, and Mr. Warren writes that they are only found on certain limited parts of the rough country on Anna Creek Station.

So far these limits constitute *Varanus giganteus* a Central Australian species, but in the British Museum Catalogue of Lizards (1885) one, the type of the species, is stated as having come from the "North Coast of Australia," which seems to indicate that the species may have a more extended range than is indicated by its Central Australian distribution.

Size.-In this respect, as might be anticipated of such relatively large lizards, one hears most exaggerated statements. The late Mr. John Bagot, however, assured me that he had seen specimens 7 ft. 6 in. in length, and I have it from Mr. Gillen that one killed by himself measured 7 ft. 2 in. The total length of the largest of the few stuffed specimens recorded in the British Museum Catalogue of Lizards (1885) is given as 206 cm, or 6 ft. 9 in., but it is not stated whether this measurement referred to the actual animal, to the skin, or to the mounted specimen. A detailed statement of the dimensions of our

own specimens will appear directly, but in the meantime it may be said that the total length of the larger of the two was 5 ft. 10 in., and of the smaller 5 ft. 4 in. and that their weights, at the close of what was practically a starvation period of more than three months, during which they manifestly lost bulk, were respectively 17 lb. and 9 lb. It will thus be seen that though not differing greatly in length there was a very marked difference in the weight of these two specimens. Not long ago we received the skin of a specimen from William Creek, the length of which, when mounted, is identical with that of the larger of our two living specimens, but this skin may have been somewhat stretched in its removal, which is very liable to happen under the hands of an unskilled operator, who was in this case an aboriginal. Relatively large amongst other lizards as are these land reptiles, they are, nevertheless, the dwarfed descendants of much larger lacertilian forms, for we have in the Museum a few vertebrae of an extinct Monitor (*Varanus priscus*, Owen) obtained at the Warburton River which, if the size may be reckoned by crocodilian comparisons, must have been 20 ft. in length, or possibly even larger.

Table showing dimensions of two specimens of *Varanus giganteus*:

	Male A. cm.	Male B. cm.	Longest Specimen in British Mus. Cat. Of Lizards (1885)
Total length	179.5	163	206
Head (maxm.)	13.6	12	14 (5)
Neck	18	15	22
Body	47.8	42.5	53
Tail	100	93.5	117
Fore limb	25.2	21	27
Hind limb	32.1	29	35
Weight, in lbs. (after 100 days' starvation period)	17	9	-

(4) This is the type specimen

(5) It is not stated whether this refers to the maximum length of the head or to that taken in the median line, which falls short of the former. In our own specimens the maximum length is given.

In the description of the conspicuous colour-markings of this species the British Museum Catalogue, while correctly stating the neck and throat to be marked with large blackish reticulations on a white ground, adds that the belly is immaculate. In the larger of the two above-mentioned Museum specimens the chest was marked by four well-marked single, irregularly zig-zagging, but on the whole, transverse black bands, and the belly by six double bands of similar disposition, the reticular pattern appearing on the sides. A very little fore-and-aft approximation, however, of the ventral bands would have formed a reticular pattern by the meeting of the angles of the zig-zag lines. In the smaller specimen the belly was marked with a reticular pattern similar to that on the sides of the neck, only much fainter in colour.

Fat-bodies (Corpora adiposa).-A median longitudinal incision through the front of the abdominal walls exposed on either side a large lobulated, dorsoventrally compressed mass of firm, bright-yellow fat, which, but for its slender vascular attachments at the posterior end, lay free in an apparently closed extra-peritoneal cavity. The inner or median wall of this cavity was formed by a smooth, tough membrane, which apparently constituted the parietal peritoneum of the abdomen, while on the outer side the fat mass lay in close contact with the glistening inner surface of the lower ribs and abdominal walls.

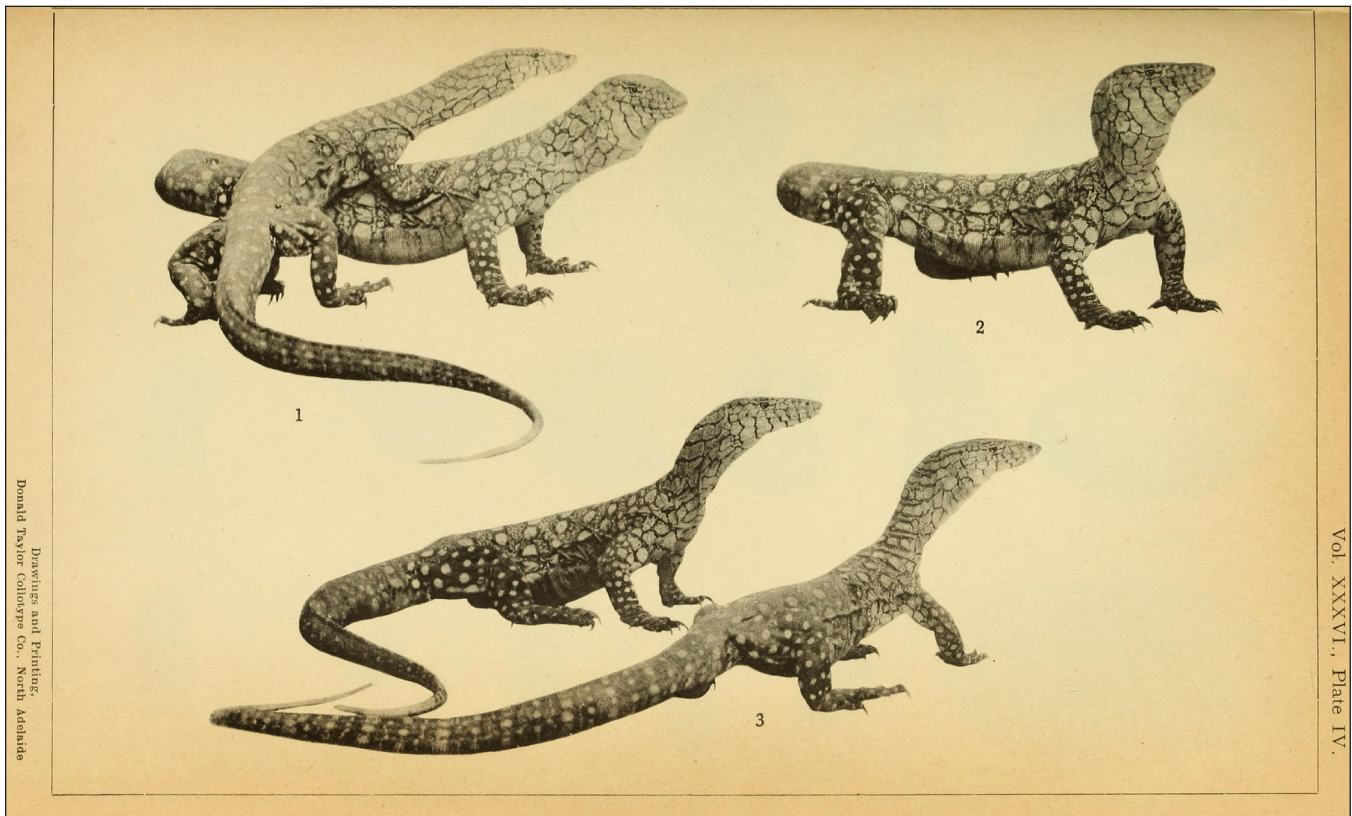
The constituent lobules composing these fat masses were, for the most part, irregularly, transversely arranged, the length of the lobules being generally coincident with the width of the adipose mass, though some fell short of this, and, in consequence of their close and accurate coaptation, the body as a whole appeared as a more or less superficially lobulated, but otherwise compact, mass. The compactness was, however, only apparent, for the constituent lobules were very easily and naturally separable from one another, being held together only by a superficial connective tissue capsule

of extreme tenuity and slight vascularity on the front and back of the organ, but of rather firmer texture at the ends of the lobules, where these together formed the lateral margins of the body. Thus, when the removed fat mass was held up by one end, the weight of the dependent lobules was sufficient to rupture to a great extent the connective tissue attachments of the lobules on the front and back, so that these fell away from one another for the greater part of their length) remaining joined chiefly at their ends, that is to say, at the lateral edges of the body, where the inter-lobular attachments were strongest. The appearance under these circumstances was that of a thick pad or cushion of fat perforated by transversely disposed fenestrae, these apertures being widest at points corresponding to the centres of the lobules and becoming narrower and more slitlike towards their ends, where they still remained attached.

The combined weight of the two masses in the largest specimen at the close of a three and a half months' starvation period was 2 lb.

Concerning the full significance of these fat bodies our knowledge is still incomplete, but according to C. K. Hoffmann (6) they correspond to the *corpora adiposa* of Amphibians and have some relation to the sexual activities, a view which is supported by their periodic increase and decrease of size. They reach, says this writer, their maximum of development in Spring. From the composition of these bodies it is also reasonable to suppose that they may serve as reservoirs of fat to be utilized for nutritional purposes during the hibernation period, but if so it is remarkable that they should still have been so large (constituting 12 per cent. of the total body weight) at the close of the long fast, when all other obvious adipose tissue had disappeared from the body. As, however, the animals when killed had evidently shrunk in bulk, particularly in respect to the region of the trunk, it is very probable that some amount of reduction in the fat masses had taken place.

(6) Bronn's Thierleben Abt 3, Reptilien (Eidechsen und Wasserechsen, p. 994).



DESCRIPTION OF PLATE IV.

Varanus giganteus.

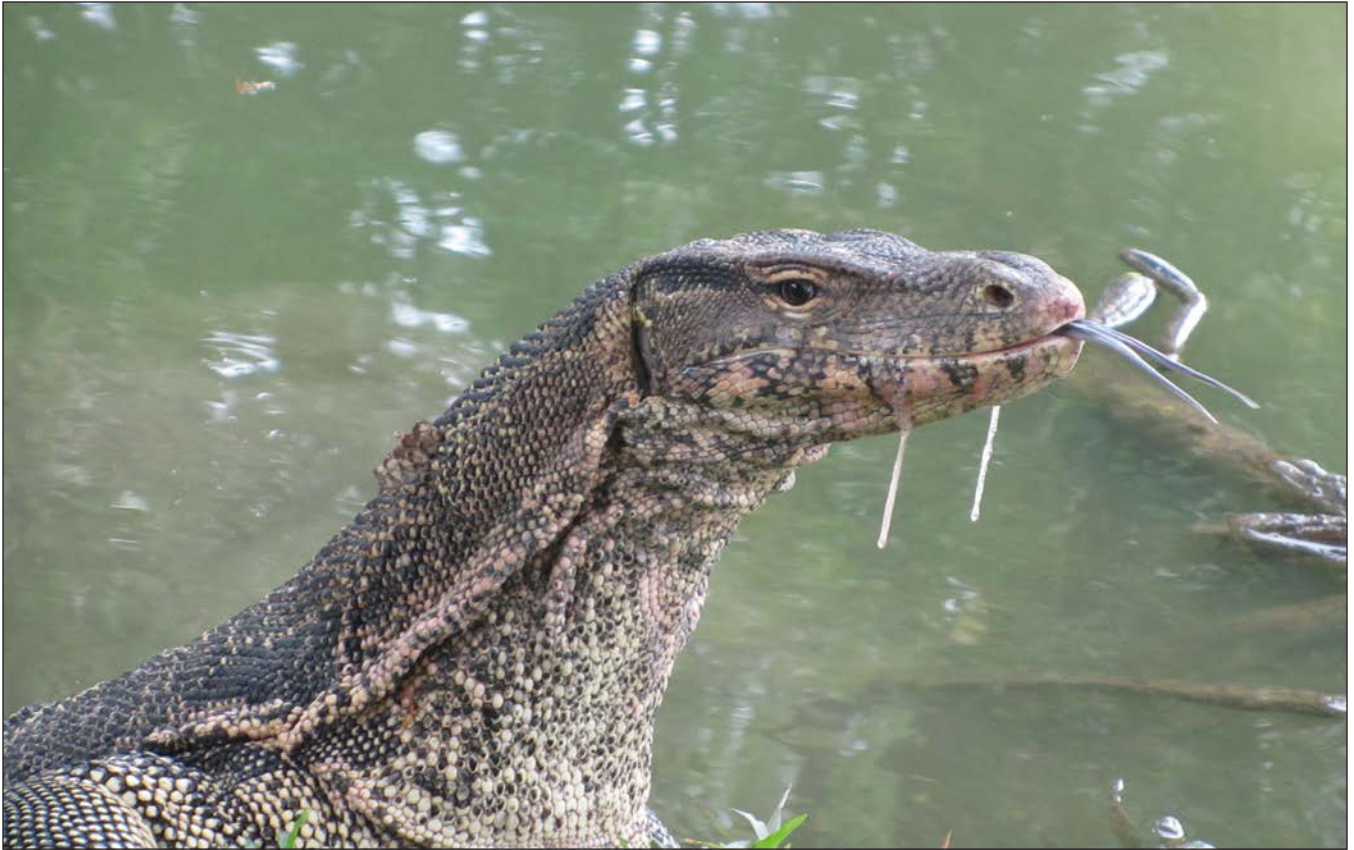
The three figures, taken from life, represent the animals in characteristic attitudes. In figs. 1 and 2 the larger specimen shows the gular pouch inflated to a moderate degree; the latter figure also shows the body completely raised from the ground, and the tail, here concealed behind the body, was also similarly raised, as well as strongly flexed. The great length of the tail is shown in figs. 1 and 3, and the snake-like appearance of the head is seen in the case of the smaller animal in both these figures.

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Varanus kordensis. Captive. Photographed by **Ryan Bungleman**.



Varanus salvator macromaculatus. Lumpini Park, Bangkok, Thailand. Photographed by **Michael Stanner**.



Varanus salvator macromaculatus feeding on black swan egg. Singapore Botanical Gardens, Singapore. Photographed by **Elvin Tan**.