

BIAWAK

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On the Cover:

Varanus komodoensis

The hatchling *Varanus komodoensis* depicted on the cover and inset of this issue are wild dragons from Ontoloe Island, Riung, North Flores. A *V. komodoensis* nest was observed by camera trap from June 2014, where female activities (*i.e.*, digging the nest and protecting the nest) were successfully recorded. The nest was fenced using a 1 m high metal sheet and covered with 1 cm mesh netting at the end of the wet season (February-March 2015), in order to capture the hatchlings upon emergence from the nest. Sixteen hatchlings were recorded emerging from the nest on 5 March 2015. Further details on this event can be found on pages 33-35 of this issue.



Cover image/top right: A Komodo dragon hatchling emerges from a nest chamber on Ontoloe Island, North Flores. Photographed by **Achmad Ariefiandy**. *Bottom:* Female dragon (left) protecting the nest from another dragon; photograph was taken from a camera trap strapped to a tree near the nest. (Photograph courtesy of the **Komodo Survival Program**).



Top left: The nest was fenced and camera traps were moved from the tree to the nest for monitoring the emergence of hatchlings. Photographed by **Sanggar Abdil Nasu**. *Top right:* The fenced nest, protected by a mesh net Photographed by **Achmad Ariefiandy**. *Bottom:* Hatchlings were released after they were measured Photographed by **Achmad Ariefiandy**.

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

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Varanus niloticus. Sensgambia Strip region, Gambia. Photographed by **Jim Cobb**.

ORGANIZATIONAL NEWS

IVIG Membership Reaches 1,000: Continues to Grow and Diversify

The International Varanid Interest Group (IVIG) continues to experience growth in both its membership and the international breadth of its readership. The period between June 2014 and August 2015 saw the addition of 83 new members, bringing IVIG membership to a total of 1000 individuals from 58 countries. New member countries include Colombia, Cyprus, Latvia and Pakistan (Fig. 1).

Now in its ninth year of publication, *Biawak* will continue to be released biannually, with new issues appearing in June and December of each year. The current issue of *Biawak* was postponed two months past its scheduled June release in order to include highlights and abstracts from the inaugural meeting of the IUCN Species Survival Commission - Monitor Lizard Specialist

Group and the Interdisciplinary World Conference on Monitor Lizards, held in conjunction with one another in Bangkok, Thailand in July 2015 (for details, see pages 11-27 in this issue).

In addition to the informational resources available through the IVIG's website, <http://varanidae.org>, a discussion group entitled "*Biawak - International Journal of Varanid Biology and Husbandry*" has been established on the popular social networking website Facebook.com to further promote and facilitate the exchange of ideas, news, and information relating to the biology and husbandry of varanid lizards. All IVIG members are encouraged to join and participate in this open forum with 1,588 current participants from around the world.

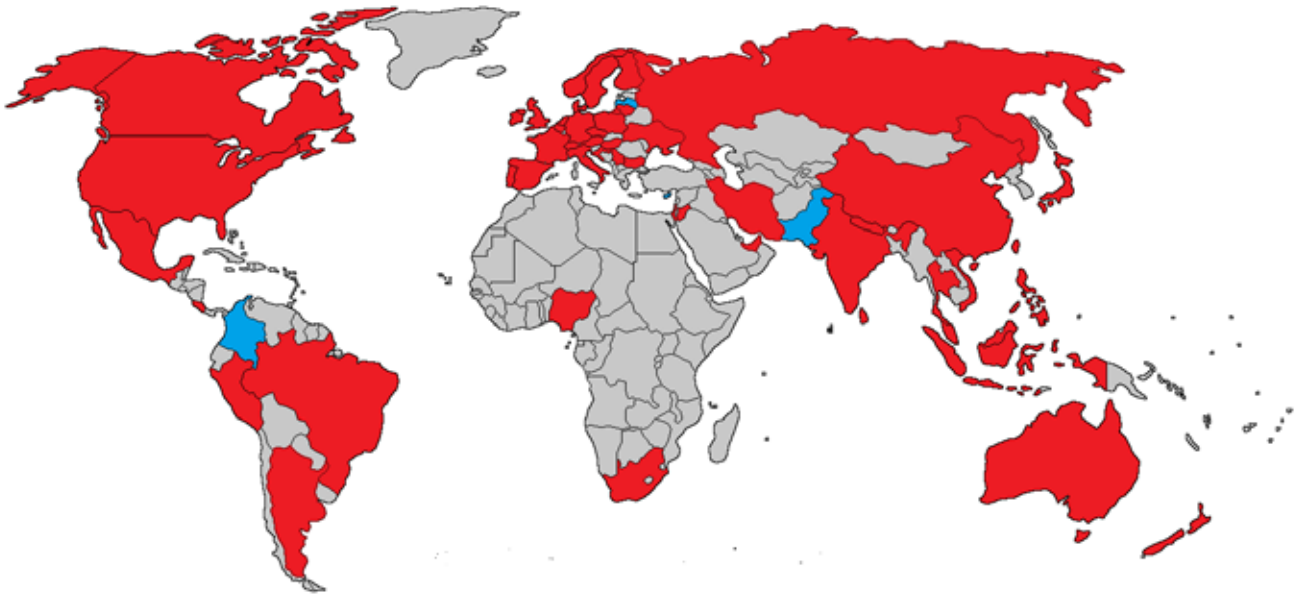


Fig. 1. Current global distribution of IVIG membership (newly added member countries in blue).

NEWS NOTES

GPS to be Used to Study Monitor Lizard Predation on Sea Turtle Nests

Researchers from the University of Queensland will begin tagging monitor lizards with GPS devices to study their effect on nests of endangered loggerhead turtles (*Caretta caretta*) on Wreck Rock Beach. This is part of a two-year project that will also test various exclusion devices to limit the predator's access to the nests. Wreck Rock Beach represents the second largest mainland nesting site in the South Pacific and monitors are estimated to take 1,000 eggs every year, making them the principle predators of the sites. Initial findings indicate that the yellow-spotted monitor (*Varanus panoptes*) is by far the largest predator of the nests; other species including the lace monitor (*Varanus varius*) serve as secondary predators, cleaning up nests after the yellow-spotted monitors have finished with them.

Source: *Brisbane Times*; 29 April 2015

Surabaya to Build Komodo Dragon Park

Surabaya officials announced plans to build a park to

house excess Komodo dragon (*Varanus komodoensis*) offspring from the city's zoo. The zoo currently houses 70 animals plus more than two-dozen eggs currently being incubated. Land is currently being surveyed in Kenjeran District to determine if it is appropriate, though other areas may be considered. It was also suggested that excess animals might be returned to the wild, though officials consider this option prohibitively expensive.

Source: *Antara News*; 2 April 2015

Monitors Lead to Discovery of Murder Victim

Villagers of Kampung Lembising, Sabah, East Malaysia discovered the body of a murdered woman after more than a dozen monitor lizards (presumably *Varanus salvator*) were seen feeding on the remains. Officials were sent out to retrieve the body. The victim is believed to be in her twenties and had been dead for at least three days prior to discovery.

Source: *The Star*; 2 April 2015



Varanus glebopalma.
Darwin region, NT. Photographed by **Lachlan Gilding**.

Houston Zoo Komodo Dragon Receives Leg Brace

A Komodo dragon (*Varanus komodoensis*) at the Houston Zoo has been fitted with a prosthetic device created by Baylor College of Medicine. The 16 year-old male, named 'Smaug', suffered from a condition in his right leg that in human medicine is known as drop-foot; weakness in the limb muscles caused the animal's foot to land on the knuckles rather than the bottom of the foot. A custom-built spring-loaded device was fitted that keeps the animal's foot in the natural position. A second device was later built to keep the toes straightened after an infection developed due to the initial period of incorrect movement. The devices are currently being worn by the dragon most of the time but are temporary and planned to be removed once the animal regains the ability to walk normally.

Sources: *Washington Post*, 10 April 2015; *Baylor College of Medicine press release*, 10 April 2015

Henry Doorly Zoo Worker Bitten by Komodo Dragon

A worker at the Henry Doorly Zoo & Aquarium in Omaha was treated after receiving a bite to her hand from a young Komodo dragon (*Varanus komodoensis*). The bite occurred as the worker was cleaning the dragon's exhibit. After zoo officials were unable to stop the bleeding (presumably due to anticoagulant factors present in the saliva of this species), the worker was taken to a hospital where she received two stitches and was later released. While the worker was also treated with antibiotics, this was taken as a standard precaution in animal bites.

Source: *Omaha World-Herald*; 1 June 2015

London Zoo Premiers New Komodo Dragon

Having last displayed *Varanus komodoensis* in 2014,

when its long term captive Raja died from illness, the London Zoo recently acquired a new male dragon, named Ganas, from Randers Zoo in Denmark. At 1.75 m in length and weighing 29 kg, the seven year old dragon is now on display in the zoo's "Land of the Giants" exhibit, and is being conditioned for target training, which would allow keepers to safely work with this individual and allow for various medical procedures. Ganas was originally hatched at the Chester Zoo and is of parthenogenetic origin.

Source: <http://ibtimes.co.uk> 7 August 2015

Monitor Lizard Saliva Erroneously Linked to Diabetes Cure

In response to rumors proliferated through social media, the United Arab Emirates' Ministry of Health issued a statement that claims surrounding a diabetes drug's link to monitor lizard saliva are erroneous and baseless. Rumors purported that Januvia, a drug registered in the UAE for treating diabetes, was extracted and derived from the saliva of monitor lizards, and that anyone who uses the medication for a year will be completely cured of diabetes. Diabetes patients were urged to consult with their physicians concerning any treatments that can affect their health.

Source: *Gulfnews.com*; 3 August 2015

Two *Varanus indicus* Seized in the Philippines

A cargo shipment containing two juvenile *Varanus indicus* were confiscated by Department of Environment and Natural Resources officials at the Davao City International Airport. The lizards were detected when the package was routinely scanned by the airport's X-ray machine. The intended final destination of the parcel was Caloocan City; the sender could not be identified. The confiscated monitors were delivered to Crocodile Park, an accredited rescue center in Davao Region.

Source: <http://sunstar.com.ph> ; 21 July 2015



Varanus baritji. Darwin region, NT. Photographed by **Lachlan Gilding**.

New Monitor Species Described – Smallest Living Representative of Genus

A new species of monitor lizard from the Dampier Peninsula of the western Kimberly region of Australia was recently described by a team of scientists led by Stephen Donnellan of the University of Adelaide. The new species, *Varanus sparnus*, has a maximum size of only 23 cm and weight of around 16 g, rendering it the smallest living representative of the genus *Varanus*.

Source: Doughty, P., L. Kealley, A. Fitch & S.C. Donnellan. 2014. A new diminutive species of *Varanus* from the Dampier Peninsula, western Kimberly region, Western Australia. *Records of the Western Australian Museum* 29: 128-140.

Bengal Monitors Face Threats in India

Increasing demand for monitor lizards in India fueled by medicinal beliefs that the meat is a powerful aphrodisiac has resulted in widespread killings of Bengal monitors (*Varanus bengalensis*) in Southern India. It is also

believed that *V. bengalensis* meat can treat rheumatic pain and even cure paralytic stroke. Demand for monitor lizard meat is particularly high at the Machilipatnam fish market, where consumers seek to collect the blood of the monitors, which is then mixed with whiskey to create what is believed to be an aphrodisiac lubricant. At the fish market, monitor lizards may fetch prices of more than Rs. 1,000 (~ \$16 USD). Wildlife biologists note that consumption of *V. bengalensis* for medicinal purposes represents a major threat to its survival, and offenders caught trading in the species may face penalties of at least seven years imprisonment, according to current wildlife laws.

Source: <http://thehindu.com> ; 14 July 2015

Komodo Dragon Euthanized

The Denver Zoo recently reported the loss of its oldest Komodo dragon (*Varanus komodoensis*), Castor, a 21 year old male that was hatched at the Cincinnati Zoo in 1994. The dragon had been in a state of decline for the last six years, with severe arthritis affecting its rear legs, and zoo staff made the difficult decision to humanely euthanize the animal. Since the onset of symptoms in 2009, treatments for the arthritis have included physical therapy, pain medications and acupuncture. Castor sired two clutches of hatchlings, resulting in seven offspring.

Three other Komodo dragons currently reside at the Denver Zoo, including Castor's 12 year old son, Raja.

Source: <http://westword.com>; 13 July 2015

Komodo Dragon Treated at Zoo Miami

A seventeen year old male Komodo dragon (*Varanus komodoensis*) at Zoo Miami is currently receiving treatment for limited mobility in its hind quarters, which sometimes resembles a type of paralysis. Animal care and veterinary staff have worked together to develop a treatment regimen which includes traditional medicine, deep tissue massage and range of motion exercise, together with hydrotherapy in the hopes of reestablishing some mobility in the animal.

Source: <http://nbc-miami.com>; 23 July 2015

L.A. Zoo Successfully Hatches *Varanus olivaceus*

The Los Angeles Zoo has recently announced the hatching of three *Varanus olivaceus* (or Butaan), achieving the rare honor of being the second facility in the Western Hemisphere in history to hatch the species. A single egg hatched at the Dallas Zoo in 1994, but the animal died shortly thereafter. There are currently only two AZA-accredited zoos in the U.S. that house *V. olivaceus*, and the L.A. Zoo has the only breeding male.

Thought to be extinct in the wild for over 130 years, this shy, fruit-eating, arboreal species was rediscovered in 1975 and can only be found on a few islands in the Philippines. Known to be one of the largest lizards in Asia, *V. olivaceus* is olive-green in color and can grow up to 1.8 m from snout to the end of its tail and weigh up to 9 kg. Very little is known about the reproductive cycles of the species, as 99 percent of their lives are spent in the canopy of trees, a fact which may play a part in why it's so hard to hatch this species in captivity.

The zoo had received clutches of eggs in the past, but according to reptile curator Ian Recchio, none have been as healthy or viable. During the 270-plus day incubation period, reptile staff closely monitored the eggs but didn't have any previous experience with hatching eggs of this

particular species. Incubation techniques were based on experience with similar Asian monitor species and *V. komodoensis* eggs.

The L.A. Zoo has held *V. olivaceus* in its collection since 1998, but all specimens were received through illegal confiscations and none were juveniles. The adults proved difficult to keep in captivity due to what they eat, an unusual diet consisting of indigenous fruit and invertebrates from the Philippines. L.A. Zoo reptile staff suspects the babies will follow suit, and they are already armed with plenty of techniques to help the hatchlings thrive like their parents. The hatchlings are currently maintained individually to manage their feedings and maintain their health. Currently, the hatchlings are responding best to food items such as snails, insects, and smaller pieces of fish.

The three recently hatched offspring are currently housed off-site at the zoo's reptile holding facility where reptile staff can carefully observe them, receiving exceptional care while being carefully observed. Once the hatchlings are well-established, the zoo hopes to share its recent knowledge of this rare species and expand the breeding program here in the United States.



Captive-bred *Varanus olivaceus*. Los Angeles Zoo. Photograph courtesy of **Ian Recchio**.

Guests can view the breeding pair of adult *V. olivaceus* at the Living Amphibians, Invertebrates, and Reptiles (LAIR) building.

Source: Modified from a Los Angeles Zoo press release; 15 June 2015



Top left & bottom: Captive-bred *V. olivaceus* at Los Angeles Zoo. Top right: Adult *V. olivaceus* at Los Angeles Zoo. Photographs courtesy of **Ian Recchio**.

Inaugural Meeting of the IUCN Monitor Lizard Specialist Group

The International Union for the Conservation of Nature and Natural Resources (IUCN) - Species Survival Commission's (SSC) Monitor Lizard Specialist Group held its inaugural meeting from 25-26 July 2015 at the Grand View Hotel, Phranakhon Rajabhat University, Bang Khen District, Bangkok, Thailand. Despite short notice of the meeting, 16 members from Asia, Australia, Europe and North America were in attendance (Fig. 1), representing roughly 1/3 of the group's current

membership. In addition to discussing a logo, website, and newsletter for the group and establishing some short- and long-term goals, participants primarily reviewed species in greatest need of Red List assessment and reassessment based on conservation priorities. Given the country's concentration of at risk endemic monitor species, it was recommended that the next IUCN-SSC Monitor Lizard Specialist Group Meeting be held in Indonesia, possibly in 2017.



Fig. 1. Attending IUCN SSC Monitor Lizard Specialist Group members. *Front row* (from left to right): Deni Purwandana, Michael Cota, Eric R. Pianka, Samuel S. Sweet, Daniel Bennett, Valter Weijola, Michael Stanner, Tim. S. Jessop, André Koch, Robert W. Mendyk, Achmad Ariefandy. *Back row*: Clayton Fischer, David S. Kirshner, Uwe Krebs, Mark Auliya.

Interdisciplinary World Conference on Monitor Lizards

From 27-29 July 2015, the Interdisciplinary World Conference on Monitor Lizards was held at the Grand View Hotel, Phranakhon Rajabhat University, Bang Khen District, Bangkok, Thailand. There were 29 participants from nine countries representing Asia, Australia, Europe and North America (Fig. 1). This was the fourth conference of its kind, and the first one held outside of Germany; previous conferences had been held at the Zoologische Forschungsmuseum Alexander Koenig in Bonn, Germany in 1989, 1997 and 2005.

To begin the conference, Eric R. Pianka of the University of Texas, Austin was presented with the “Auffenberg Medal”, a lifetime achievement award from his fellow varanid researchers in recognition of his lifelong dedication and contributions to the study of monitor lizards (Fig. 2).

A total of 19 presentations were given, touching upon such topics as ecology and conservation, taxonomy and systematics, evolution, reproductive biology, physiology, behavior, microbiology, captive husbandry, breeding and veterinary management, and historical illustrations. Several posters were also presented, touching on historical museum collections, microbiology, and captive husbandry and reproduction. Abstracts for these presentations and posters are included in this issue (see pages 14-27).

Several field trips enabled participants to visit various herpetology-related institutions and sites in the region. Prior to the start of the conference, there were trips to the Natural History Museum, National Science Museum of Thailand to view the public exhibits and collections, and to the Dusit Zoo, to observe



Fig. 1. Attendees of the 2015 World Interdisciplinary Conference on Monitor Lizards, Bangkok, Thailand. *Front row* (from left to right): Deni Purwandana, Ian Recchio, Jose A. Navas-Molina, Embriette R. Hyde, Michael Cota, Eric R. Pianka, Michael Stanner, Lauren Augustine, Tim Trout, Achmad Ariefandy, Patrick Campbell. *Second row*: Francesc Clave Escrig, Alvaro Camina, Clayton Fischer, Tim Jessop, Daniel Bennett, André Koch, Edgar Wefer, Samuel S. Sweet, Wendy Knight, Adam Davis, Mark Auliya, Jonathan Murray. *Back row*: David Kirshner, Uwe Krebs, Valter Weijola, Robert W. Mendyk.



Fig. 2. Eric R. Pianka receives the "Auffenberg Medal" for his lifetime achievements in monitor lizard research.

Thailand's largest free-ranging, urban population of water monitors, *Varanus salvator macromaculatus* (Figs. 3 & 4). After the conference, most participants joined in a two day trip to Khao Yai National Park, where a number of reptile and amphibian species were observed in the field, including *Crocodylus siamensis*, *Malayopython reticulatus*, *Trimeresurus vogeli*, *V. salvator*, *Physignathus cocincinus*, *Gekko gecko*, *Pythozoon lionatum*, *Gehyra mutilata*, *Hemidactylus*

frenatus, *H. platyurus*, *Sphenomorphus maculatus*, *Duttaphrynus melanostictus*, *Hylarana nigrovittata*, *H. mortenseni*, *Microhyla berdmorei*, *M. fissipes*, *Polypedates leucomystax* and *Theloderma stellatum*.

There will be a conference proceedings published, as there had been for previous monitor lizard conferences. Once the proceedings are ready for publication, information will be made available on how to order.



Figs. 3 & 4. Free-ranging *Varanus salvator macromaculatus* on the grounds of Dusit Zoo, Bangkok. Photographed by **Robert W. Mendyk**.

Abstracts from the 2015 World Interdisciplinary Conference on Monitor Lizards

Presentation Abstracts

Field Observations by Two American Varanophiles

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Here we describe some of the challenges and experiences we encountered in our studies of Australian monitor lizards over many months of fieldwork. We begin with some general statements about varanid lizards, then each of us describes some of his own personal experiences with these extraordinary lizards. SSS studied tropical species exploiting radio-tracking to follow individuals over long periods of time. ERP studied desert species collecting them as museum specimens, which were dissected to gather data on reproduction and stomach contents. He presents a food web that includes 41 species of desert lizards including 7 species of monitor lizards as top predators. We conclude by comparing our results with an emphasis on species richness of varanids coexisting in Australia.

The Polillo Butaan Project 1999-2010; Lessons Learned in the Study of *Varanus olivaceus* Howell, 1857

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Varanus olivaceus, commonly known as butaan, is a frugivorous monitor lizard restricted to lowland dipterocarp forests in southern Luzon and three adjacent islands (Catanduanes, Polillo and Alabat) in the Philippines. Populations on Luzon and Catanduanes were the subject of a 22 month study by Walter Auffenberg in the 1970s, relying on methods that are no longer available. The principle aims of the Polillo Butaan Project were to develop non-destructive and, where possible, non-intrusive methods to investigate aspects of the ecology and population status of the animals in a fragment (approx 220 ha) of unlogged forest and adjacent smaller areas of secondary forest on Polillo island, and to actively conserve the population within the study area. This presentation discusses successes and failures of the project, and their implications for future ecological studies and in-situ conservation efforts for frugivorous monitor lizards.

Integrative Taxonomic Revision of the *Varanus timorensis* (Gray, 1831) Group (Squamata: Varanidae)

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Insufficient taxonomic expertise and capacity are the main reasons why a large amount of the global biodiversity is still not discovered and described. Consequently, our knowledge, not only about the world's countless invertebrates, but also about species groups of larger vertebrates, such as monitor lizards, suffers from this taxonomic impediment. At the same time, these giant reptiles are highly demanded by the ever-hungry international pet trade due to their attractive colour patterns. Therefore, lack of taxonomic resolution may have severe consequences for the conservation of unrecognized endemic taxa. With an integrative approach, we addressed the open taxonomic questions posed by the *Varanus timorensis* species group, an assemblage of dwarf monitor lizards, that currently consists of four monotypic species (*V. timorensis*, *V. auffenbergi*, *V. similis*, and *V. scalaris*) inhabiting northern Australia, New Guinea, and the Timor Archipelago. As a result two locally endemic taxa of this understudied monitor lizard group, a subspecies and a species from the Timor Archipelago, are recognized as new. Consequently, *V. timorensis* is revealed to be polytypic. In addition, two hitherto dubious Papua-Australian taxa, kuranda and pengilleyi, deserve revalidation due to significant diagnostic characters in the integration by partial congruence (IPC) protocol we applied, which represents a balanced and pragmatic trade-off approach for integrative taxonomic revisions.

Do the Hatchlings of Dumeril's Monitor (*Varanus dumerilii*) Schlegel, 1839 display Batesian Mimicry? A Conspicuous Phenomenon and its Presumptive Evidence

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An analysis of batesian mimicry in the hatchling Dumeril Monitor (*Varanus dumerilii*) is made. The analysis is done by defining Batesian mimicry, and setting conditions for batesian mimicry. The species which hatchling *Varanus dumerilii* mimic are identified by appearance, common geographic distribution, and behavior. The possible predators of are systematically described, and compared to the conditions set for batesian mimicry, their distribution in comparison to *Varanus dumerilii* and those species that it mimics. Lines of circumstantial evidence, due to lack of natural history information, are used to show which species hatchling *Varanus dumerilii* mimic and the predators that are targets of, and most likely fooled by this mimicry.

Reproduction of the Rare, Frugivorous Monitor, *Varanus olivaceus* Hallowell (1857) at the Los Angeles Zoo

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The butaan, *Varanus olivaceus*, has been an enigmatic creature to the scientific community, avoiding detection by many competent biologists for 130 years. Until the monumental works of Auffenberg in the 1970s, and most recently Bennett, almost nothing was known of this lizard's biology. We now understand it is one of three known highly arboreal and primarily frugivorous monitors, all of which are endemic to the Philippines. Specimens of this shy monitor species trickled into captive collections through legal and illegal means since its rediscovery. Due to its highly specialized lifestyle, captive specimens have proven difficult keep or reproduce. The Los Angeles Zoo has worked almost continually with butaan since 1998, when four specimens were seized by the United States Fish and Wildlife Service and transferred for safe keeping to the Zoo. In 2015, the zoo's work culminated in the first complete clutch to be hatched in the Western hemisphere. A total of four offspring were successfully hatched from four fertile eggs. A second larger clutch of eight fertile eggs are incubating and due to hatch in July 2015. The Los Angeles Zoo has utilized many strategies, some typical and some unusual, to induce reproduction, incubate eggs, and ultimately raise young butaan. These techniques will all be discussed in some detail.

Nesting Behaviors of Wild Sydney Heath Monitors, *Varanus rosenbergi*

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The heath monitor, *Varanus rosenbergi*, is considered to be the most studied of all Australian monitors due to long-term research on Kangaroo Island, but the NSW population is relatively poorly known. Aspects of nesting behavior in heath monitors in the region of Sydney, NSW, were recorded on camera during opportunistic visits to specific termite mounds in late summer over an 8 year period. Nesting typically took place from February into early March and females usually remained near the nest for an extended period after egg-laying. Recorded observations included nest digging and backfilling, evidence of two females nesting in the same termite mound in a single nesting season, intra-specific nest marauding by a male *V. rosenbergi*, an attempt at inter-specific nest marauding by *V. varius*, and nest defense by a female *V. rosenbergi* against the latter.

Chasing Flamingos: Toxicofera and the Misinterpretation of Venom in Varanid Lizards

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The recently-proposed Squamate clade Toxicofera requires the abandonment of a number of well-studied macroevolutionary trends in morphology, behavior and ecology, leaving it its place hundreds of *de facto* convergences and rendering much of the fossil record contradictory. No significant morphological features are synapomorphies of the Toxicofera, which is based on gene sequences in very short branches uniting snakes, iguanian and anguimorph lizards. As currently understood, the genes support this clade, but it is sufficiently in conflict with so much other evidence that great skepticism remains warranted. One of the pillars supporting the Toxicofera (and the source of the name) is the claim that expression of venom genes in salivary glands is a synapomorphy (a shared, derived trait). This has recently been shown to be false, the genes being expressed in geckos and in multiple tissue types in various squamates. The further claim that monitor lizards (Varanidae) are venomous does not withstand careful examination. Venom gland structures are present in the lower jaw, but evidence for toxicity of monitor bites is generally lacking. Monitors kill most large prey more quickly than venom could act, and are in turn killed so quickly by most predators that little deterrent effect can exist. One potential exception is as a defense against constricting snakes, but detailed work on this possibility remains to be done.

What Best Determines Survival Rates of *Varanus komodoensis*: Prey, Density-dependence or Inbreeding?

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Island endemics are especially sensitive to extinction. Though one or more ecological, demographic or genetic processes maybe implicated in causes of island population declines, estimation and ranking of such processes is rarely undertaken hindering prioritization of management actions needed to prevent island extinctions. Here we integrated long-term capture-mark-recapture analysis, prey surveys and molecular

analysis to estimate survival rate variation in Komodo dragon (*Varanus komodoensis*) at 10 sites on four islands in Komodo National Park, Indonesia. Using open population capture-recapture methods we ranked competing models that considered ecological, genetic and demographic effects on site specific survival estimates in Komodo dragons. Variation in survival ranged from 0.54 (95% CI: 0.41-0.68) to 0.81 (0.67-0.90) among sites. The best ranked model ($\omega_i = 0.50$) indicated that ungulate prey abundance most influenced Komodo dragon survival. However model support for Komodo dragon density and inbreeding coefficients effects further contributed to survival rate variation. These results suggested hierarchical but additive effects of ecological, density-dependent and genetic (*i.e.* inbreeding) processes acting on Komodo dragon survival. Hence to ensure Komodo dragon persistence, National Park authorities must maintain habitat security to support ungulate prey and possibly consider assisted gene flow to bolster genetic and demographic viability in these iconic lizards.

The Feeding Act in a Few Varanid Species: A Description with Systematic and Evolutionary Implications

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By means of existence the feeding act of all organisms is an important interface between organism and habitat. In a phylogenetical perspective it could be postulated that high evolutionary pressure will be laying on optimizing this behavioral act and this is the case in monitor lizards as well and even especially because of their challenging function in most species as carnivore hunters. The contribution deals with the mixture of genetically fixed behavioral parts and learned behavioral parts of the feeding act in order to meet an optimal solution to the problem. Fragments of the behavior of *V. albigularis*, *V. acanthurus*, *V. beccarii* and *V. dumerilii* on this matter are mentioned. A 9.5 minute film shows the complicated overpowering and feeding of a big living Chinese mitten crab by a tame *V. dumerilii* and –in contrast – of a mouse. Finally, a few general conclusions on the feeding act are presented.

Burrowing Behavior and Burrowing-derived Behavior of *Varanus griseus* (Daudin, 1803)

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Burrowing is one of the major activities of *Varanus griseus* and it is engaged in it frequently. The burrowing behaviors of *V. griseus* in the field, as well as in captivity are described. A presumable innate burrowing instinct which is activated in certain stressful conditions is discussed. A burrowing-derived behavior, *i.e.* digging motions with one of the forefeet is described and assumed to be a manifestation of displacement

activity that is activated by stress, conflict or frustration. The burrowing behavior and the burrowing-derived behavior of *V. griseus* are compared to the pecking behavior and pecking-derived behavior of woodpeckers.

A Comparative Assessment of Varanid Lizard (Reptilia: Squamata) Thermal Husbandry in Zoos and Private Collections: Disparate Ideologies or a Paradigm Disconnect?

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Over the past two centuries, zoos and private herpetoculturists have played crucial roles in advancing understanding of reptilian biology. As poikilothermic ectotherms, captivity-based investigations on reptiles and their long-term keeping and breeding success necessitate that captives are maintained under optimal environmental conditions to ensure a normal and healthy physiology. From a historical perspective, herpetological husbandry practices have often differed between zoos and private herpetoculturists due to a number of factors including, but not limited to different keeping philosophies, spatial constraints and available resources. To identify and better understand some of the differences existing between these two groups, this study assessed thermal husbandry practices currently offered to varanid lizards (Genus: *Varanus*) in captivity. A survey of these practices in 31 North American zoos and 236 private collections in 21 countries revealed marked differences in thermal husbandry between zoos and private keepers. Furthermore, this study identified the continued use of keeping methodologies that conflict with what is currently known about varanid thermal biology. In light of these findings, we identify specific areas of thermal husbandry in both zoos and private collections that can be improved upon and highlight the need for improved communication and collaboration between these two keeping groups in advancing varanid husbandry and breeding and understanding of their biology.

Veterinary Care and Practice with Varanid Lizards

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In veterinary practices for exotic animals, reptiles are perhaps one of the most important groups because their popularity as pets has increased in recent decades. Within this large group, monitor lizards have been

gaining ground in private collections and zoos. Therefore, it has been collecting more and more information about the most common health problems of these lizards. This lecture, will be focused on the most common problems that have been treated by the author, a veterinarian specializing in reptiles for over fifteen years. There will be exposed clinical cases seen and managed at the veterinary clinic and zoological institutions. Commenting on this, the origins of the problems are discussed, as well as treatment and prevention. This talk will be supported by a variety of images and videos to make it much more understandable.

The Captive Komodo Dragon Microbiome: Novel Taxa, Inter-zoo Variation, and Comparison to Other Reptiles

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While some believe that the Komodo dragon (*Varanus komodoensis*) kills its prey by introducing pathogenic bacteria into bite wounds, others believe that the dragon's deadly bite is due to venom. A number of groups have identified both pathogenic and non-pathogenic bacteria in Komodo saliva, but the reliance of these studies on culture-based techniques limit their ability to deeply characterize the Komodo dragon oral microbiome. Here we use 16S rRNA gene amplification and deep sequencing to describe the stool, skin, and oral microbiomes of captive Komodo dragons in twelve zoos across the United States. We identified 25 novel bacterial taxa, some of which appeared to be related to bacterial taxa that are capable of producing debilitating blood infections in mammalian hosts, such as *Pasteurella*, *Bacteroides*, and *Clostridium*. Microbiome diversity and composition was also similar between skin and saliva microbiomes, but not the stool microbiome. We additionally compared the Komodo dragon microbiomes to those of three other varanids: the Gray's monitor (*Varanus olivaceus*), the Mangrove monitor (*Varanus indicus*), and the Roughneck monitor (*Varanus rudicollis*), as well as the venomous prairie rattlesnake, which purportedly shares a venomous common ancestor with varanids. Our analyses revealed that the Komodo dragon stool, skin, and salivary microbiomes are most similar to the Gray's monitor microbiomes, Mangrove and Roughneck monitors are more similar to one another than to Komodos or Gray's monitors, and the prairie rattlesnake microbiomes are largely dissimilar from those of the varanids. Altogether, our results comprise the most thorough captive Komodo dragon microbiome study to date, expanding our knowledge of Komodo microbial ecology and highlighting the need for further studies both in captive and wild Komodos and other varanids to thoroughly understand the complex relationship between these animals and their microbes.

Examining Multi-scale Effects of the Invasive Fox on a Large Varanid (*Varanus varius*; White, 1790) Mesopredator

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The mesopredator release hypothesis and theory of intra-guild predation emphasize that interactions between coexisting predators may be strong and important to population and community dynamics. This is because predators not only compete for food resources but large predators frequently kill smaller predators and suppress their abundances. Across Australia suppression of native and introduced carnivores (e.g. dingoes [*Canis lupis dingo*] and red foxes [*Vulpes vulpes*]) using poison baits containing sodium flouracetate (“1080”) is likely to disrupt predator-prey and competitive interactions that follows the manipulation of top predator abundances. Currently there is little understanding of how top predator suppression affects Australia’s predator guilds and especially the large and common Varanid lizards. However, given the importance, and even potential negative consequences, of mesopredator release, evaluation of the effects of top predator suppression on native predators is vital. Here we investigated the effects that a large scale red fox (5-7 kg), suppression program had on a large predatory lizard the Lace monitor (*Varanus varius*, 4-7 kg). We evaluated the effects of fox suppression on proxies of *V. varius* population status using count surveys in replicated poison baited and non-poison baited control areas. We compared the effects of fox baiting on the maximal body size and body condition of lizards, their sex ratio to infer further consequences of potential competition between foxes and *V. varius*. We found increased population counts and higher site occupancy of *V. varius* in poison-baited areas relative to control areas. Lizards in fox baited sites were also in better body condition, but neither maximal body size nor sex ratio differed between baited and control treatment areas. Our study shows that: 1) Fox management, via 1080 baiting, can benefit *V. varius*; 2) *V. varius* functions as a mesopredator in the presence of foxes and 3) mesopredator release is not restricted to interactions between vertebrate species of the same order.

Komodo Dragons (*Varanus komodoensis*, Ouwens 1912) on Flores Island: A Grand Conservation Challenge

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The Komodo dragon *Varanus komodoensis* is endemic to five islands in southeastern Indonesia. Four of these islands (Komodo, Rinca, Nusa Kode and Gili Motang) are part of Komodo National Park. Until the early 1970s,

Komodo dragons were also common on the western, northern and northeastern coast of Flores. Since then, population densities have decreased mainly as a result of expansion of human settlements and forest clearance to slash-and-burn agriculture. On Flores, *V. komodoensis* is now mainly found on the western coast in the Wae Wuul nature reserve and on the northern coast in the Wolo Tadho, Riung and Tjujuh belas pulau reserves.

In Komodo National Park, *V. komodoensis* populations are well protected and regularly monitored. An intensive population monitoring program has been conducted since 2001. Komodo dragon populations are relatively stable on Komodo and Rinca Islands, while some indication of slight decline is evident on the smaller islands of Nusa Kode and Gili Motang. Information on the current status of *V. komodoensis* on Flores is instead relatively scant, extant populations have faced multiple human-related threats over the past 30 years. On northern Flores, for instance, *V. komodoensis* was since recently captured and often killed to avoid predation on livestock.

Since 2008, the Indonesian NGO Komodo Survival Program has been working in collaboration with the Indonesian Eastern Lesser Sunda Central Bureau for Conservation of Nature Resources (BBKSDA) on a multidisciplinary initiative integrating population monitoring techniques, community awareness plans and capacity building for the conservation of extant Komodo dragon populations on Flores. The goal is to help management authorities conserve Komodo dragons with the involvement of the local community.

During the first four years, an intensive conservation program was conducted in the Wae Wuul nature reserve on West Flores. Afterwards, from 2012, the project expanded to northern Flores. On the West coast of Flores, the Wae Wuul ranger post was completely rebuilt, community awareness and involvement of local people in habitat-protection schemes were regularly and successfully implemented, local rangers were trained in wildlife-monitoring techniques and annual population monitoring was conducted. Live cage trapping and camera trapping were used to monitor Komodo dragon population. Results indicated that Komodo dragon densities are lower in Wae Wuul than in the adjacent Komodo National Park. However, a relatively high level of genetic diversity was recorded for this population. Ungulate prey showed a relatively stable prey population density.

Population monitoring surveys is also being conducted on the North coast of Flores, particularly on Ontoloe Island, in the Tjujuh belas pulau reserve, in the Riung nature reserve and in the monsoon forest close to the Pota district. Recently, nesting activity of a female Komodo dragon was documented on Ontoloe Island. Community awareness and involvement of local people in habitat-protection schemes were implemented, and local rangers were trained in wildlife-monitoring techniques. Moreover, a three-year expedition was started to collect information on the current Komodo dragon distribution across the entire Flores coastal areas.

On Flores, unclear reserve boundaries, habitat encroachment, Komodo dragon prey poaching and different attitudes of local community on the importance of biodiversity have so far made Komodo dragon conservation efforts more challenging than in Komodo National Park. The work conducted by Komodo Survival Program is slowly improving natural habitat and wildlife protection schemes. The involvement of Indonesian stakeholders, including local government authorities and BBKSDA is much needed, and maintenance of community-based initiatives and regular wildlife monitoring are crucial to ensure persistence of Komodo dragons on Flores. Future activities will also begin to address climate change impacts could threaten population alongside identifying additional habitats to increase protect areas and optimize Komodo dragon conservation.

Living Lizard Shit: The Diet of *Varanus olivaceus* on Polillo and its Role as a Seed Disperser

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Between 1999 and 2008 a total of 1754 fecal clumps of the frugivorous monitor lizard *Varanus olivaceus* were located in approx 400ha of primary and secondary lowland dipterocarp fragments around Sibulan Watershed Reserve, Polillo Island, Philippines. Abundance of common fruiting species important in the diet was estimated by measuring densities in transects totaling 5.5 ha. For rare, dioecious, species attempts were made to calculate absolute abundance of fruit-producing individuals. Likely local competitors for fruit were identified using direct observation, camera traps and literature searches. The positions of fecal clumps were mapped and related to the distribution of reproductive individuals, adults and seedlings of species of fruit prominent in the diet of the lizard. Assuming that the nearest reproductive tree was the origin of seeds in feces, seed dispersal kernels and minimum dispersal distances were calculated. To investigate seed fate, germination rates of seeds from clumps were measured in situ. Feces were comprised almost entirely of the fruits of ten species belonging to seven genera/five families of plants, and two species of snails. *Pandanus* and *Gnetum* trees were more common in degraded areas than in intact forest, but densities for other fruiting species did not change with habitat. Fruit consumption by the lizard was strongly correlated with fruit abundance for three species but showed no relationship in six other species. Average minimum dispersal distances by lizards were 114-126 m for *Canarium* species, 46-93 m for *Pandanus* spp. and 38 m for *Microcos*. In situ rates of germination were lowest for *Canarium* species and highest for *Pinanga*, *Caryota* and *Microcos*. Rates of seed loss were highest for *Canarium* sp. and *Microcos* and lowest for *Pandanus* sp. and *Caryota*. The results suggest that 1) *V. olivaceus* does not alter its diet in degraded habitats and is probably unable to survive in the absence of *Canarium* and *Pandanus* trees and 2) local extinction of the lizard would result in the cessation of much of the long distance dispersal of *Canarium* and all of the long distance dispersal of *Pandanus* species in the area. These findings highlight the importance of “specialized” fruiting trees in the feeding ecology of the species and support the hypothesis that rare forest frugivores depend largely on rare fruit types.

The Scale Ultrastructure of Monitor Lizards (Squamata: Varanidae: *Varanus* spp.) and their Allies: Implications for Systematics, Evolution, and Conservation

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We analysed scale contour, shape and additional characters from five different body regions using scanning electron microscopy (SEM) across all nine recognized subgenera of the monitor lizard genus *Varanus* Merrem, 1820 including 41 different species investigated. This qualitative visual technique was applied by

us in this study for the first time to most monitor lizard species and probably also to the primary outgroup *Lanthanotus borneensis*. A comprehensive list of 20 scalation characters and up to seven corresponding character states was established and defined for each of the sampled body regions. For the phylogenetic approach, parsimony analyses of the resulting morphological data matrix as well as Bremer and bootstrap support calculations were performed with the software TNT. Our results demonstrate that a specific microornamentation (i.e., ultra- or microdermatoglyphics) as seen in various squamate groups is hardly present in monitor lizards. In several species of ecologically distinct groups, however, we found a honeycomb-like microstructure (polygons), the taxonomic and/or ecological significance of which remains unclear. In addition, the systematic affiliation of *V. spinulosus* Mertens, 1941, a rare species from the Solomon Islands with an unusual scale structure, is discussed in the light of current hypotheses about its phylogenetic position within the Varanidae. Due to its unique scale structure, in combination with other morphological evidence, a new monotypic subgenus seems justified for this enigmatic monitor species. Furthermore, we propose a taxonomic splitting of the morphologically and ecologically heterogeneous subgenus *Euprepiosaurus* Fitzinger, 1843 comprising the Pacific or mangrove and tree monitor lizards, respectively, again based on the SEM data. Thus, for the members of the highly arboreal *V. prasinus* (Schlegel, 1844) species group erection of a new subgenus is warranted based on the autapomorphic scale shape in concert with further morphological, phylogenetic and ecological evidence. Notably, the established scalation characters allow discrimination of single species, even among closely-related *Varanus* species, such as the members of the *V. indicus* (Daudin, 1802) species group. Together with a recently published identification key for Southeast Asian monitor lizards based on macroscopic phenotypic characters (Koch *et al.* 2013, Herp. Con. Biol, 8, Monogr. 3: 1-62), the SEM-pictures of the present study may serve as addition references for the microscopic identification of CITES-relevant monitor lizard skins and products.

Drawing Monitors: A Multicentennial History of Varanid Lizard Illustrations

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Monitor lizards, or varanids, have attracted the attention and interest of humans for several millennia, with the earliest artistic representations of varanids appearing in cultural artifacts, hieroglyphs, petroglyphs and sculptures of various ancient civilizations from northern Africa and the Middle East as well as the Indian subcontinent and Australia. In Europe, a region bereft of indigenous monitor lizards, depictions of varanids first appeared as woodcuts in early 17th century works on natural history. With the emergence of the field of natural history and the expansion of European trade networks to Africa, Asia and Australia, these illustrations introduced readers to species found in distant, exotic lands, but also served as taxonomic iconotypes and provided visual representations which accompanied the descriptions of new species. As printing technologies evolved from woodcuts to copperplate engravings to lithographs, the artistic quality and realism of these illustrations improved, leading to some magnificently detailed representations and celebrated works of art. By the early 20th century, hand-drawn illustrations had largely been replaced by photographs in works on herpetology and natural history, and today represent relics of a bygone era. This presentation reflects on this fascinating period of natural history illustrations and showcases many of the important works depicting monitor lizards from the 17th to early 20th centuries.

The Monitor Lizards of Thailand

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The monitors of Thailand have been recognized by the relevant national authorities in Thailand as consisting of four taxa: *Varanus bengalensis nebulosus* or *V. nebulosus*, *V. dumerilii*, *V. rudicollis*, and *V. salvator* (Nabhitabhata *et al.*, 2000; Nabhitabhata & Chan-ard, 2005). There have been other taxa in Thailand which have been recorded, with evidence (*V. bengalensis bengalensis*), without evidence (*V. flavescens*), or have been synonymized (*V. salvator komaini*). These are discussed to give more clarification of the valid taxa in Thailand. Geographic distribution and habitats for the known taxa in Thailand are discussed as well as some ecological notes.

Poster Abstracts

Husbandry and Breeding of *Varanus prasinus* at the Bristol Zoo Gardens

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Bristol Zoological Gardens' reptile collection has housed the emerald tree monitor since 2001, although only in 2004 was a female specimen obtained to start breeding the species. The first success came in 2005 with the hatching of a single animal, but since then we have bred the species successfully in eight of the last 11 years (we were without a breeding female during 2011-12).

During this period we have bred from three different males, and four different females. Fertility and viability of both eggs and clutches have varied greatly, although it appears to have improved over the last couple of years, with 3 out of 4 clutches from our current female incubated successfully.

Tree monitors are a common species displayed in many EAZA zoological collections due to their attractive appearance and their tendency to display well as active diurnal lizards. *V. prasinus* are one of only two species of monitor lizard that is being managed as a studbook species (ESB or EEP) within EAZA, alongside *V. komodoensis*.

There are many published accounts of breeding not just *V. prasinus*, but most of the *V. prasinus* complex of tree monitors, however it appears EAZA collections are still not breeding this group of monitors in great numbers nor with much consistency. Using the Zoological Information Management System it is recorded that over the last three years, only 11 *V. prasinus* have been hatched between three EAZA zoos, despite having 55 adults (26 females) among 25 collections. Over the same time period, no *V. beccarii* were hatched with 36 adults (17 females) maintained in nine collections; 48 *V. macraei* hatched at 4 collections with 51 adults (22 females) housed in 17 collections; and no *V. reisingeri*, *V. kordensis* or *V. boehmei* have been hatched from 9 adult specimens housed between three zoos.

This poster outlines the husbandry of *Varanus prasinus* at Bristol Zoo Gardens that has been used to successfully breed this species with some regularity, and hopefully with increasing consistency.

Characterization of Captive Komodo Dragon-Environmental Microbiome Sharing and a Comparison of this Sharing to Wild Amphibians and Urbanized Humans

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A key question in studies of animals in their environments, including captivity, is the extent and directionality of interchange with the environment. Questioning the plausibility of the bacteria as venom hypothesis as the explanation for the morbidity and mortality of the Komodo dragon (*Varanus komodoensis*) bite, Fry *et al.* posited that pathogenic bacteria are passively acquired from their prey or other environmental sources, and that these pathogenic bacteria play no role in prey acquisition. However, environmental microbiomes have been largely ignored in studies of the Komodo dragon microbiome.

Using 16S rRNA marker gene sequencing, we use culture-independent techniques to characterize Komodo dragon environmental, salivary, skin, and fecal microbiomes and to characterize host-environment microbiome sharing. We show that both the richness and the composition of most material in the Komodo dragon environment is similar to the Komodo salivary and skin microbiomes, but less similar to the fecal microbiome. We also find that, unlike amphibians studied in wild environments, the captive Komodo dragon largely contributes its microbes to its sealed enclosures, as do humans in their built environments. Additionally, the Komodo environmental microbiome is very specific to Komodo dragons, with no human or amphibian sources identified as contributing to the environmental microbiome, and individual dragon enclosures were highly individual to the dragon residing in them, with differential microbial communities that could discriminate between enclosures. The results of this cross-species comparison have important implications for animal health and conservation efforts, as the state of an organism being surrounded primarily by its own microbes in a sealed environment may be a radical departure from the microbial communities and exposures with which vertebrates have co-evolved.

A First Description of the Biology of *Varanus bitatawa* Welton *et al.* 2010

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Varanus bitatawa is a large frugivorous monitor lizard endemic to the North Eastern side of the Sierra Madre Mountain range in Luzon, Philippines. First described to science in 2010 there has been no subsequent publication on this species and little is known about its ecology and diet. Field research was conducted over two locations in Isabela and Cagayan Province from June to August 2013. Lizards were caught and fitted with a spool and line device, subsequent thread trails were recorded and camera traps utilised to establish patterns of tree use and activity area. Faecal samples were examined to determine diet and habitat characterised using the Point Centre Quarter Method. Catch per Unit Effort (CPUE) was calculated by number of individuals sighted/number of hours searching, giving a CPUE of 0.095 at the study location in Isabela and a CPUE of 0.127 in Cagayan. Five lizards with a snout to vent length above 40 cm were caught and tracked for between 4 and 17 days. Activity areas were non-overlapping with a mean of 1.24 ha. Movements were characterized by straight line distances between trees with a mean distance travelled between trees of 79m and a mean daily distance of 176m. Consumption of fruits from *Pandanus*, *Canarium* and *Microcos stylocarpa* was evident in faecal samples, from spool and line tracking observations, and from camera trap images. The frugivorous diet was supplemented with molluscs and insects belonging to the orders *Orthoptera*, *Phasmatodea* and *Coleoptera* indicating that it has a seasonal omnivorous diet comparable to its southern congener *V. olivaceus*. Predominantly arboreal, *V. bitatawa* showed reliance on large sentinel trees with a mean circumference at breast height (CBH) of 176.28 cm, significantly larger than the mean CBH of trees in sampled habitats. Shy and reclusive, *V. bitatawa* are vulnerable to disturbance, threatened by hunting pressure for local human consumption and for a burgeoning pet trade in exotic reptiles. Selective logging further degrades remaining habitat threatening the large dipterocarp trees on which they rely. Further study to determine a baseline estimate of population size and area of occupancy is recommended to determine a conservation status.

ARTICLES

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Water Monitor Lizards for Sale as Novelty Food in Java, Indonesia

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Abstract – Monitor lizards are not widely thought of as food in Muslim-dominated countries or areas. The island of Java, with 140 million people of whom over 95% are Muslim, is a case in point. Despite this, water monitor lizard *Varanus salvator* meat is traded and consumed, as a novelty food, as a remedy for a range of ailments (skin diseases, eczema, asthma) and as an aphrodisiac. There are at least 23 cities where restaurants or food stalls sell this type of meat, showing its wide availability throughout the island. Self-reported turnover data by traders in Jakarta (1-3 *V. salvator* sold each day), Semarang (5/day) and Banyuwangi (15/day) suggest annual Java-wide turnovers of tens of thousands of *V. salvator* a year to meet the demand from the domestic meat trade. *Varanus salvator* is not protected under Indonesian law, but its commercial harvest and trade is subject to a strict quota system. The domestic *V. salvator* meat trade is not included in the quotas as these are largely allocated for export to wholesale traders, and thus the domestic trade appears in violation of Indonesia's wildlife trade regulations. It is imperative that the domestic trade is taken into account when quotas are set, to ensure that real-world harvest levels do not exceed what is sustainable for the species.

Two decades ago, Klemens & Thorbjarnarson (1995) reviewed the use of reptiles as food sources and listed Gray's monitor lizard *Varanus olivaceus* [incorrectly listed as *V. griseus*] as being consumed in the Philippines, and unspecified species of monitor lizards in Zambia and Congo DRC, whereas Alves *et al.* (2008) reviewed the use of reptiles for traditional medicinal purposes and singled out the Bengal monitor *V. bengalensis* as being used in India and China, and the desert monitor *V. griseus* in Azerbaijan, and unspecified species of monitor lizards in Vietnam. Bolton (1972) gave a detailed account how monitor lizards were considered edible or not by the various tribes or different age and sex groups within tribes inhabiting Peninsular Malaysia, showing that at a small geographical scale the consumption of monitor lizards differs widely. Uyeda *et al.* (2014) recently reported on the consumption of *V. salvator* meat in two villages in Banten Province, Java, Indonesia, where 14 out of 55 participants interviewed about the uses of *V. salvator* had knowledge or first-hand

experience of this. All participants agreed upon its use as a remedy for common skin ailments and eczema, with two participants indicating that they had occasionally eaten *V. salvator* meat as a source of protein as opposed to a medical treatment. Uyeda *et al.* (2014) noted that *V. salvator* are not often consumed as a source of protein in Indonesia and that their study area was located in a predominantly Muslim area, where *V. salvator* are generally not consumed as a regular dietary item or source of protein due to religious beliefs.

Despite Java being largely populated by Muslims (over 95% of its 140 million inhabitants are followers of Islam; Ricklefs, 2012), the consumption of *V. salvator* meat is far more widespread in Java than Uyeda *et al.* (2014) indicate. It is eaten for a variety of reasons and in fact may have increased in popularity in recent years. Here, I give a brief overview on some recent reports of the consumption of *V. salvator* in Java, provide an insight into the legality of this trade, and conclude with some recommendations for better regulation of this

trade.

Varanus salvator, known as biawak in Indonesian, bayawak in Sundanese and nyambik in Javanese (these being the three main languages spoken on Java), are consumed on Java for medicinal purposes or as a novelty food; the latter with or without perceived additional health benefits. In addition to it being a perceived cure for skin diseases, it is widely believed that *V. salvator* meat cures asthma and maintains a healthy immune system (Anonymous, 2009, 2013a, 2014b; Arisnagara, 2009). Anonymous (2009), Ahmad (2013) and Baihaqi (2011) report that *V. salvator* meat increases a man's sex drive and acts as an aphrodisiac. While most reports attribute these benefits to the consumption of the meat, Anonymous (2013a) states that it is not the meat but the rendered fat of *V. salvator* that has to be used to cure burns, skin allergies or hives. Dasuki (2013) indicates that this has now become so popular that "water monitor lizard's oil" is sold bottled. The perceived health benefits of consuming *V. salvator* meat (or rendered fat) seem to vary in the different parts of Java.

Arisnagara (2009) surveyed ten vendors in Jakarta that sold reptiles for medicinal or novelty food purposes; all had *V. salvator* meat available for purchase, making it, alongside the Javan spitting cobra *Naja sputatrix*, the most widespread species offered by these traders. Its popularity as a culinary delicacy is also stressed by Dasuki (2013). The meat, liver and bones are cooked in a host of different ways, and the skin is fried to make crackers (Rochman, 2014). *Varanus salvator* meat is sold in the form of satay (skewers with small pieces of meat, grilled and served with peanut sauce, sweet soya sauce, chilies and shallots), soup, fried or cooked in stews, as well as dried ('abon'). Food stalls offering *V. salvator* meat often sell other 'exotic' meats as well, including rabbit, snakes, and bats (Ahmad, 2013; Arisnagara, 2009; Pokardas, 2014). The social movement of wanting to act upon one's love of exotic foods, including exotic meats, has become known as 'kuliner ekstrim'¹ in Java, and participants have plenty of places to go to.

Varanus salvator meat is widely available, with reports of restaurants and food stalls selling it throughout Jakarta (Bandengan, Mangga Besar, Kelapa

Gading districts) (Arisnagara, 2009; Anonymous, 2010; 2014a; Pokardas, 2014) and in Bogor (Anonymous, 1999), Bandung and Lembang (Ahmad, 2013); all in West Java. In Central Java it is sold in Pekalongan (Kholidah, 2009), Semarang (Dasuki, 2013), Banyumas (Anonymous, 2009a) and Surakarta, (Legowo, 2012), Depok in Yogyakarta (Anonymous 2015), and in East Java in Ngawi (Anonymous, 2013b), Surabaya (Baihaqi, 2011), Malang (ProFauna, 2012), Kediri (Mashudi, 2013), Banyuwangi (Rochman, 2014), Pasuruan and Balongbendo (Prinatono, 2012). Popular restaurant search websites such as YukMakan.com, AyoJajan.com, JogjaBagus.com and OpenRice.com list restaurants selling *V. salvator* meat in Tangerang (Banten), Jakarta, Yogyakarta, Purwokerto (Central Java), Sidoarjo and Tulungagung (East Java).

While it appears that there has been an increase in attention paid to the sale of *V. salvator* meat in Java, it is by no means a recent addition to the menu of the inhabitants of Java. Anonymous (2015) gives an account of a restaurant in Depok (Yogyakarta) that had been selling *V. salvator* meat since 1973. Kholidah (2009) reported on a restaurant in Pekalongan that started selling it in 1997. Anonymous (1999) reported on a *V. salvator* catcher selling his quarry to restaurants in Bogor in the late 1990s. Anonymous (2009) reported on a food stall in Banyumas, Central Java, selling it for over seven years, dating back to at least the early 2000s. Dasuki (2013) reported on a restaurant in Semarang, Central Java that has offered *V. salvator* meat for over ten years (2003 or earlier) and Baihaqi (2011) indicated that *V. salvator* meat had been put on the menu of a Surabaya food stall in 2009.

Anonymous (1999) reported that according to the offices of the Directorate General of Forest Protection and Nature Conservation (PHKA) in Bogor, the sale of *V. salvator* in Java is legal, as it is not a protected species, with one of the PHKA officers acknowledging that he had eaten it himself. While it is correct that *V. salvator* is not included on the list of protected species in Indonesia (Noerjito & Maryanto, 2001), the commercial sale of wildlife in Indonesia is strictly regulated. All monitor lizards are listed on Appendix

¹ The 'kuliner ekstrim' (also spelled as ekstrem) movement seems to be a relatively recent development. The earliest reference I found to it in an Indonesian context dates back to 2009 when it is used by numerous bloggers and writers (e.g., Anonymous, 2009bc); a Google search for 2014 gave over 35 articles or blogs specifically referring to 'kuliner ekstrim' in various parts of Indonesia. This either suggest that more people are aware of it, more people write about it, or that consuming novelty food has become more popular. Unfortunately it is not possible to directly link this to a possible increase the volumes of *V. salvator* consumed on Java.

II or I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), to which Indonesia is a signatory. For the commercial exploitation of species that are included on one of the appendices of CITES, an annual quota system is in place that is controlled by the Ministry of Forestry (Shepherd & Nijman, 2007). By decree of the Ministry of Forestry (No. 447/Kpts-11/2003), all harvest or capture and distribution of wild plant and animal specimens has to be done under a license. Collectors, middlemen, and suppliers must be registered with Regional Offices for the Natural Resources Conservation Agency (BKSDA), an agency under the Directorate General of Forest Protection and Nature Conservation that is responsible for the regulation of wildlife trade at the provincial level (Siswomartono, 1998). Quotas are set annually for all non-protected species, and these are divided so that each province that made a harvest request gets a part of the quota. The quota-setting process is conducted through an annual meeting of various stakeholders including PHKA, and the Indonesian Institute of Sciences (LIPI), relevant NGOs and licensed wildlife traders (Shepherd & Nijman, 2007). Annual quotas for *V. salvator* for Java are typically in the order of some 30,000 individuals, with 90% of these intended for export (PHKA, 2007, 2008; Arisnagara, 2009; Koch *et al.*, 2013); these quotas are allocated to members of the Indonesian Reptile and Amphibian Trade Association, most of whom are wholesale exporters (Shepherd & Nijman, 2007).

As argued by Arisnagara (2009), it is highly unlikely that the people that harvest *V. salvator* for the

domestic meat and medicinal markets are licensed by and registered with their respective Regional Offices for the Natural Resources Conservation Agency. Likewise, it is unlikely that those that sell *V. salvator* in restaurants have been allocated part of the quota; if so, these commercial *V. salvator* traders are in violation of the law. Note that large numbers of *V. salvator* are killed for the international skin trade (*i.e.*, typically > 400,000 / year; PHKA, 2007, 2008; Koch *et al.*, 2013), but the permitted harvest of these is largely restricted to the islands of Sumatra (~250,000 / year) and Indonesian Borneo (~150,000 / year) (PHKA, 2007, 2008), and this trade seems to be fully separate from the domestic trade for meat and medicinal purposes as described here for Java.

It is difficult to assess what impact the domestic meat trade has on wild populations of *V. salvator*. Three reports give an indication of the turnover of *V. salvator* for the meat trade, and these vary widely. If we assume that an average *V. salvator* gives some 2 kg of sellable meat, then traders in Jakarta sell the meat of between one and three monitors a day (Arisnagara, 2009), one restaurant in Semarang of five monitors a day (Dasuki, 2013), and a food stall owner near Banyuwangi of 15 monitors a day (Rochman, 2014). The combined total number of *V. salvator* needed by these 13 restaurants on an annual basis to supply this demand totals some 12,500 individuals (Fig. 1).

If the data in Fig. 1 are representative of the trade in *V. salvator* on Java, and there is no reason to assume it is not, and conservatively estimating the number

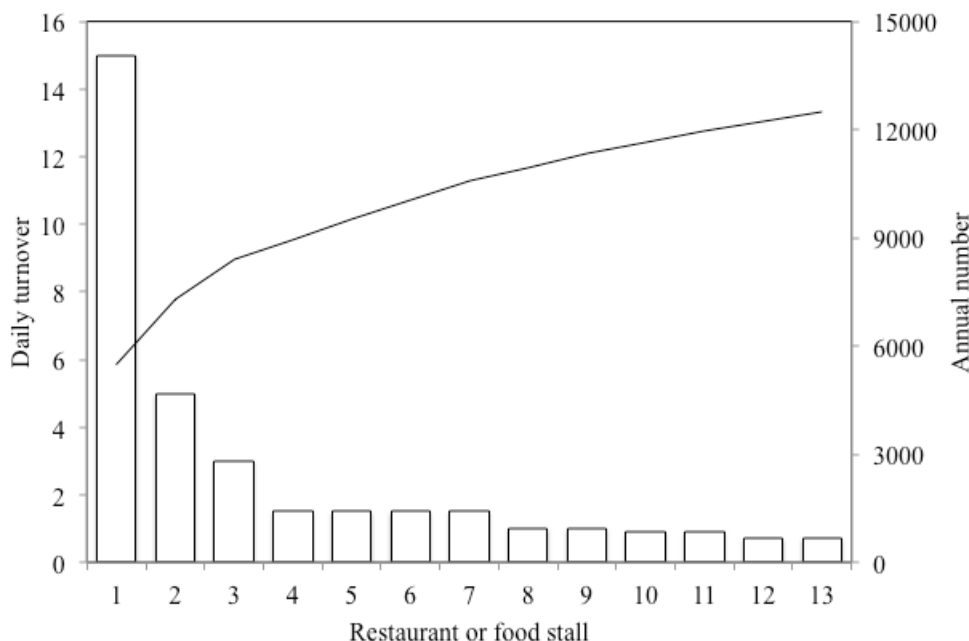


Fig. 1. Daily turnover (number of *Varanus salvator* consumed per day) by 13 restaurants or food stalls in three cities on Java (bars) and the cumulative number of *V. salvator* needed on an annual basis to supply this demand.

of restaurants and food stalls at 50 (Jakarta alone has over ten: Arisnagara, 2009; and see listing above), this would mean close to 50,000 *V. salvator* are needed to supply this demand. It is important to note that given the distribution of turnover data, a few restaurants are responsible for the bulk of this trade (one food stall in Banyuwangi needs over 5,000 *V. salvator* each year to meet the demand from its customers; Rochman, 2014).

Java is an island with some 140 million people; the majority of them will never consume *V. salvator* (cf. Uyeda *et al.*, 2014), but a small minority can consume a large number of them even if eaten only as novelty food or to relieve the symptoms of a wide range of ailments. This assessment of the domestic trade in *V. salvator* in Java adds to a small number of other studies in Indonesia. Iskandar (2004) recorded that people in the Malinau region of North Kalimantan, consumed not only *V. salvator*, but also the black roughneck monitor, *V. rudicollis* and possibly a third smaller monitor lizard species. Based on interviews with 147 hunters in the province of West Papua, Pangau-Adam *et al.* (2012) concluded that close to a thousand peach-throated monitors, *V. jobiensis* were killed a year for domestic consumption. The domestic trade in monitor lizards on Java and indeed other parts of Indonesia has gone largely unnoticed. It therefore seems unlikely that domestic off-take has been taken into account when assessing the sustainability of the harvest volumes intended for international export. I urge the Directorate General of Forest Protection and Nature Conservation and the Indonesian Institute of Sciences to take this into account at the earliest opportunity when future annual harvest quotas are set.

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First Record of Komodo Dragon Nesting Activity and Hatchling Emergence from North Flores, Eastern Indonesia

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Abstract - For wild varanid populations, basic measures of reproductive ecology, such as distribution and selection of nest sites, are difficult to obtain. To date, nest distributions and nesting behavior for Komodo dragons (*Varanus komodoensis*) have only been reported from Komodo National Park. Here we report the first record of *V. komodoensis* nesting activity and hatchling emergence on Ontoloe Island, off the north coast of Flores. This is a significant finding for it suggests that this relatively small but well protected island supports a viable population of *V. komodoensis*.

A key factor in Komodo dragon (*Varanus komodoensis*) conservation is a comprehensive understanding of processes that influence population persistence (Jessop *et al.*, 2007; Purwandana *et al.*, 2014, 2015). Basic attributes of female reproductive ecology, such as the annual number of reproductive females, and the habitat and the physical characteristics that influence both distribution and selection of nest sites are core aspects, necessary to facilitate informed decisions regarding the management and conservation

of this species (Jessop *et al.*, 2004).

Surveys and observations of wild *V. komodoensis* nest distribution and nesting behavior have been reported from Komodo National Park (Jessop *et al.*, 2004; Purwandana, 2007). This research suggested relatively low densities of nests across Komodo Island and that lizards preferred to nest in the abandoned nest mounds of the orange-footed scrubfowl *Megapodius reinwardt* (Jessop *et al.*, 2004). The annual nesting cycle begins with females preparing their nests in June and July.



Fig. 1. A Komodo dragon hatchling emerging from the nest chamber on Ontoloe Island, North Flores. Photographed by Achmad Ariefiandy.

Oviposition then takes place in August, and females will guard their nests until November (Purwandana, 2007). Emergence of hatchlings takes place from February to April. Hatchlings then immediately disperse to nearby trees to enter an arboreal life-stage that lasts for 1-2 years (Imansyah *et al.*, 2008).

Observations of nest use and hatchling emergence outside of Komodo National Park (*i.e.*, Flores Island) remain undescribed. In this study, we report the first observation of *V. komodoensis* nesting activity on Ontoloe Island (08°22'16.2" S; 121° 00' 45.2" E), part of the Tujuh Belas Pulau Nature Reserve, in North Flores. Since 2008, surveys on *V. komodoensis* populations on Flores Island have been conducted extensively by the Komodo Survival Program, an Indonesian non-governmental organization working in collaboration with the Indonesian Lesser Sunda Center for Conservation of Nature Resources (BBKSDA NTT). In November 2013, we found an orange-footed scrubfowl nest with signs of recent digging activity and *V. komodoensis* tracks, which suggested that the nest was visited and possibly used by a *V. komodoensis* as a nesting site. The nest was located in dry *Tamarindus indica* woodland and received partial

shade (~ 40%) from adjacent vegetation.

We placed four ScoutGuard SG560V (Boly Media Communications Inc., Santa Clara, USA) wildlife cameras around the nest as described in Ariefiandy *et al.* (2013) from June to November 2014 in order to confirm *V. komodoensis* nesting activities. The cameras recorded a female digging nest chambers and protecting the nest from other adult dragons. This provided further evidence of the female using the scrubfowl nest for oviposition. In November 2014, the female *V. komodoensis* was no longer recorded on camera traps. The nest was then fenced using a 1 m high metal sheet and covered with 1 cm mesh netting in order to capture the hatchlings upon emergence from the nest at the end of the wet season (February-March 2015). Intensive daily observations were conducted to determine the presence of emerged hatchlings. On 5 March 2015, 16 hatchlings emerged from the nest (Fig. 1). Hatchlings were measured and tagged using a passive integrated transponder (TROVAN 100A, Trovan Ltd, London, UK). Average total body length and mass of hatchlings were 46.5 ± 0.3 SE cm (range: 44.6-48.9 cm) and 105.1 ± 2.2 SE g (range: 83-121 g), respectively. A blood sample was also collected

from the caudal vein. All hatchlings were released on large trees close to the nest.

This is the first record of Komodo dragon nesting activity and hatchling emergence in Flores, and represents a significant finding for it suggests that Ontole Island, a relatively small but well protected island, supports a viable population of *V. komodoensis*. It is also an important result considering that, unlike Komodo National Park, Flores is subject to significant levels of habitat disturbance that have significantly affected extant *V. komodoensis* populations since 1970 (Ciofi & De Boer 2004; Ariefandy *et al.*, 2015).

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Varanus primordius. Darwin region, NT. Photographed by **Lachlan Gilding**.

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Varanus panoptes. Mount Isa, Queensland. Photographed by **Bernd Eidenmüller**.



Varanus griseus griseus. Assa, Morocco. Photographed by **Markus Oulehla**.