2015

Varanus Panoptes (Yellow-Spotted Monitor) Toxic Prey Avoidance

J. Sean Doody

Hugh James

Christopher Walmsley

David Rhind

Matt Edgar

See next page for additional authors

Authors
J. Sean Doody, Hugh James, Christopher Walmsley, David Rhind, Matt Edgar, Maik Fidel, Domenic D'Amore, Simon Clulow, and Colin McHenry

in the Yellow-spotted Monitor, *Varanus panoptes*, in northern Australia.

The Yellow-spotted Monitor is a large lizard (up to 1.5 m in total length) inhabiting riparian areas and floodplains in tropical Australia (Cogger 2000. Reptiles and Amphibians of Australia. Reed New Holland, Sydney. 808 pp.). It is a generalist carnivore consuming mammals, frogs, reptiles, fish, invertebrates, and the eggs of reptiles and birds (Christian 2004. *In* Pianka and King [eds.], Varanoid Lizards of the World, pp. 423–429. Indiana University Press, Bloomington and Indianapolis. 588 pp.). Invertebrates eaten include orthopterans, ants, lepidopterans, spiders, centipedes, roaches, hemipterans, beetles, trichopterans, and crabs (Christian 2004, *op. cit.*). Studies of *V. panoptes* diet are based mainly on dissections of museum specimens, and on stomach flushing of live individuals, although a few observations of feeding and prey capture have recently been published (Shannon 2008. Biawak 2:80–86; Shannon and Mendyk 2009. Biawak 3:85–87; Rhind and Doody 2011. Herpetofauna 41:64–65; Doody et al. 2012a. Herpetol. Rev. 43:339–340; Doody et al. 2012b. Herpetol. Rev. 43:491–492; Rhind et al. 2013. Herpetol. Rev. 44:516–517; Rhind et al. 2014. Herpetol. Rev. 45:335–336). Collectively, these studies and observations indicate that *V. panoptes* is capable of a wide range of foraging behaviors including capturing fast prey, subduing large prey, excavating inactive or hidden prey including eggs, foraging for aquatic prey, raiding poultry pens, and scavenging roadkill and human consumable waste.

At 0935 h on 9 July 2010 we observed, photographed, and videoed a large male *V. panoptes* tearing apart a cattle dung pat on the campground at El Questro Station, El Questro Wilderness Park, in the Kimberley Region of Western Australia (16.006297°N, 127.979819°E) (http://dx.doi.org/10.6084/m9.figshare.1281287). Upon closer examination (within 3 m) we observed the lizard to: 1) tongue-flick in and around the pat; 2) tear apart the pat with alternating forelimbs; 3) press its nose into the pat; and 4) capture small prey items and swallow them. Although we could not confirm it with absolute certainty, the prey items appeared to be dung beetles, which we later found to be relatively common in other dung pats in the area (there were no other similar-sized invertebrates in the 10 pats we examined). After the lizard tore apart the pat, it proceeded in a straight line to another pat 7 m away. In this way the lizard tore apart seven dung pats in a ~30-minute period. The pats were all within a 50-m^2 area. The dung pats were from cattle, which invade the campground to forage on green grass late in the dry season. The campground is encompassed by the Station, a million-acre property that supports ~5000 head of cattle (M. Bass, pers. comm.).

Varanus bengalensis forages for dung beetles in the dung pats of cattle, elephants, rhinoceros, donkeys, camels, blackbuck, nilgai, horses, and canids (Auffenberg 1994, *op. cit.*). In particular, *V. bengalensis* regularly visited bovine dunging sites, which contained a rich and diverse abundance of dung beetles. The lizards also demonstrated spatial memory, visiting but not disturbing fresh dung pats which have few beetles, then revisiting the pats days later when beetle densities were higher. We do not know if the *V. panoptes* knew of the dung pats previously; however, the lizard clearly focused on dung pats exclusively during the feeding bout. Earlier in the year when dung pats are not available at the site, we commonly observe *V. panoptes* foraging in the campground on mowed grass for buried prey including beetle larvae, hymenopteran larvae, and frogs. They also occasionally scavenge on human food items. Other producers of significant amounts of dung in the east Kimberley are feral donkeys, horses, cattle, and pigs. Dung foraging in monitors may be a relic; historically, prominent megafauna would have provided an abundance of dung pats and beetles for ancestral species of large monitors. Auffenberg (1994, *op. cit.*) estimated that the habit of gleaning dung beetles from Bovine pats by Asian monitors extended back into the Pliocene, based on fossil evidence from the Varanidae, Bovidae, and Scarabaeidae.

The great breadth of both food types and foraging strategies in *V. panoptes* probably increases the likelihood of individual variation of both. Individual variation in prey preference may be critical for the viability of *V. panoptes* populations in the Kimberley Region as they face the invading Cane Toad (*Rhinella marina*). *Varanus panoptes* is one of three species of monitor lizards that suffers severe population-level declines, via lethal toxic ingestion, with the invasion of Cane Toads (e.g., 83–96%, Doody et al. 2009. Anim. Conserv. 12:46–53). Toads have since invaded El Questro in 2012–2013. Perhaps individuals that prefer non-frog prey such as invertebrates will comprise the proportion of animals surviving the toad invasion.

J. SEAN DOODY, Department of Ecology and Evolutionary Biology, University of Tennessee, 569 Dabney Hall, Knoxville, Tennessee 37996-1610, USA (e-mail: jseandoody@gmail.com); **GRAEME SAWYER**, 19 Tasman Circuit, Wagaman, Northern Territory 0810, Australia (e-mail: graemes@entity1.com); **KIM HANDS**, Stop the Toad Foundation, 2 Delhi Street, West Perth, Western Australia 6005, Australia (e-mail: kim@stopthetoad.org.au).

***VARANUS PANOPTES* (Yellow-spotted Monitor). TOXIC PREY AVOIDANCE.** It is well established that toxic Cane Toads (*Rhinella marina*) poison some predator species attempting to ingest them (Lever 2001. Cane Toad: The History and Ecology of a Successful Colonist. Westbury, Yorkshire). In a few species this interaction translates into strong, population-level impacts; for example, *Varanus panoptes* suffers population declines of about 90% upon toad arrival (Doody et al. 2009. Anim. Conserv. 12:46–53; Ujvari and Madsen 2009. Herpetol. Conserv. Biol. 4:248–251). However, it is not known whether the surviving ~10% possessed genetic-based immunity (Ujvari et al. 2013. Evolution 67:289–294), an innate adaptive avoidance of frogs, or whether non-lethal encounters result in lizards learning to avoid Cane Toads (Llewelyn et al. 2013. Austral. Ecol. 39:190–197). Behavioral observations, while insufficient alone to allow distinguishing among those hypotheses, can clarify interactions that can facilitate choosing which hypothesis is the best to pursue. While studying the nesting biology of *V. panoptes* in the Kimberley region of tropical Australia, we captured video of a natural interaction between a *V. panoptes* and a Cane Toad, soon after the arrival of toads to the site.

In April and May 2013 we monitored four *V. panoptes* nesting warrens for female activity using Moutrie I-35® remote game cameras at El Questro Wilderness Park, Western Australia (15.895033°S, 128.132456°E). The site is mainly woodland savannah and is in the wet-dry tropics; the nesting warrens were in the sandhill of a riparian area. Cameras were placed on the trunks of small trees near the burrow entrances of warrens. Two of the cameras were set to take still photographs and two set to take short videos with an associated photograph (30 sec in duration). At 0829 h on 1 May a video captured the interaction of an adult gravid female *V. panoptes* and an adult Cane Toad (http://dx.doi.org/10.6084/m9.figshare.1281314). The video begins by showing the lizard with its head turned towards the toad, which was sitting in shade next to a burrow opening (Fig. 1). The direction of her gaze and repeated tongue-flicking (6 flicks in that posture for 10

FIG. 1. Game camera photograph of a gravid female *Varanus panoptes* near the entrance of her nesting burrow, looking towards a Cane Toad (*Rhinella marina*) that is sitting at the base of a small tree (in shadow). The dust in the air is a result of the lizard's digging action just before the photograph was taken.

seconds), suggested that she was aware of the toad's presence. At 11 seconds the lizard turned away from the toad and burrow entrance, at which time the toad hopped quickly into the burrow, possibly in response to the lizard's movement. The lizard walked slowly about 0.5 m away from the burrow, during which time she flicked her tongue nine times; at 24 seconds the lizard ceased tongue-flicking and flattened out her body and basked in a patch of sunlight for the last 6 seconds of the video. Toads had arrived at the site during the previous wet season, sometime between November 2012 and March 2013. When we excavated the warrens in May and June most of the burrows contained 1–4 adult toads. Over the next few weeks the lizard completed her nesting in the same burrow, and was seen several times during this process, indicating that she was not a victim of toad poisoning. Excavation of her burrow revealed her eggs but no more toads.

As far as we know, this is the first direct observation of the interaction between a *V. panoptes* and a Cane Toad in nature (but see Llewelyn et al. 2013, *op. cit.*, for field experiments in which *V. panoptes* were offered toads from a noose). The lizard, which was clearly large enough to consume the toad, was not toad-naïve, but may not have experienced toad toxin. It is possible that the lizard was satiated, or that *V. panoptes* do not feed while gravid, or during the nesting process. However, it is equally likely that the lizard avoided the toad due to either innate avoidance or a learned response to toad poisoning. Further monitoring of *V. panoptes* nesting warrens as toads arrive could reveal insightful interactions that clarify the behavioral repertoire of *V. panoptes* for dealing with Cane Toads. These interactions could help disentangle competing hypotheses underpinning the surviving 10% of *V. panoptes* during the Cane Toad invasion.

J. SEAN DOODY, Department of Ecology and Evolutionary Biology, University of Tennessee, 569 Dabney Hall, Knoxville, Tennessee 37996-1610, USA (e-mail: jseandoody@gmail.com); **HUGH JAMES**, School of Environmental and Life Sciences, University of Newcastle, Callaghan, New South Wales 2308, Australia (e-mail: hugh.james@uon.edu.au); **CHRISTOPHER W. WALMSLEY**, Department of Anatomy and Developmental Biology, Monash University, Clayton, Victoria 3800, Australia (e-mail: c.w.walmsley@gmail.com); **DAVID RHIND**, Department of Anatomy and Developmental Biology, Monash University, Clayton, Victoria, Australia, 3800 (e-mail: darhi1@student.monash.edu); **MATT EDGAR**, School of Environmental and Life Sciences, University of Newcastle, Callaghan, New South Wales 2308, Australia (e-mail: medgar1900@gmail.com); **MAIK FIDEL**, 2/151 Main Road, Lower Plenty, Victoria 3093, Australia (e-mail: mantis_maik@hotmail.com); **DOMENIC D'AMORE**, Department of Natural Sciences, Daemen College, 4380 Main Street, Amherst, New York 14226, USA (e-mail: ddamore@daemen.edu); **SIMON CLULOW**, School of Environmental and Life Sciences, University of Newcastle, Callaghan, New South Wales 2308, Australia (e-mail: simon.clulow@newcastle.edu.au); **COLIN McHENRY**, Department of Anatomy and Developmental Biology, Monash University, Clayton, Victoria 3800, Australia (e-mail: colin.mchenry@monash.edu).

***WOODWORTHIA MACULATA* (Common Gecko). LEUCISM.** Leucism is a condition where the lack of deposition of melanin in the skin results in a white or pale coloration of the animal, but the eyes maintain normal pigmentation (cf. albinism; Bechtel 1995. Reptile and Amphibian Variants: Colors, Patterns, and Scales. Krieger Publishing Co., Malabar, Florida. 206 pp.). Leucism can vary from partial (<25%, also defined as piebaldism) to completely white individuals (van Grouw 2006. Dutch Birding 28:79–89; Rocha and Rebelo 2010. Herpetol. Notes 3:361–362). Occurrence of leucistic New Zealand geckos in the wild are uncommon (T. Jewell, pers. comm.) and the few observations are generally not recorded.

On 25 February 2014, several *Woodworthia maculata* were caught at dusk, under a pile of rocks close to the shoreline at an island in Whakatane, New Zealand. One of the three individuals was an adult female (SVL = 67 mm) with very pale white

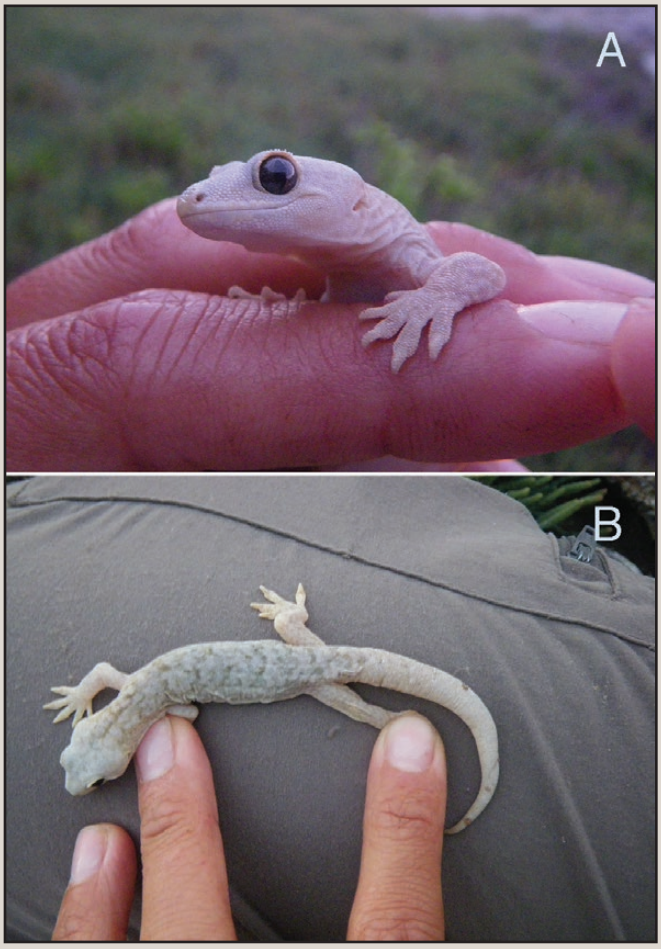

FIG. 1. Leucistic female *Woodworthia maculata*, (A) lateral head showing the pigmented eyes, and (B) light patterning on the dorsal region.