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Observation records of the Bangon Monitor Lizard, *Varanus bangonorum* (Squamata, Varanidae), with emphasis on behaviour and local threats, from the Municipality of Abra de Ilog, Occidental Mindoro, Philippines

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Abstract

Varanus bangonorum, the Bangon Monitor Lizard, is one of eleven Varanidae species endemic to the Philippines; its occurrence is restricted to dwindling habitats on the islands of Mindoro and Semirara. This lizard is still poorly known and is presently classified as "Least Concern" under the IUCN Red List in 2022. Observations recorded during eleven years (2011 to 2022) originate from the north-central Municipality of Abra de Ilog in Occidental Mindoro where this species was never before documented. We emphasise the primary factors that pose threats to the monitor lizard population, including insights gained from the knowledge of local community members. We present information about the lizards' diet, for example, they can consume invasive toxic cane toads without harm. The result of our collective long-term observation records may serve as a baseline for further studies and contribute to evaluating the conservation status of this species.

Key Words

Bayawak, foraging behaviour, herpetofauna of the Philippines, monitor lizard, new locality records

Introduction

The Philippines is a tropical archipelago of 7641 islands (Kinser 2020) bordered by the Pacific Ocean to the east and the West Philippine Sea (South China Sea). Two major seasons determine the climate: a rainy season from June to November and a dry season from December to May, with noticeable temperature drops from December to February (Philippine Atmospheric, Geophysical, and Astronomical Services Administration 2022). Stated as one of the world's eighteen mega-biodiverse countries (Convention on Biological Diversity 2022), the Philippines hosts a high percentage of endemic species, including eleven species of Varanidae (Auliya and Koch 2020). All are protected under national law and are classified as Critically Endangered (1), Vulnerable (2) and Other Threatened Species (8) by the Department of Environment and Natural Resources (2019).

One of the representatives of this family is *Varanus bangonorum* Bangon Monitor Lizard or Mindoro Water Monitor (Welton et al. 2014; Eidenmüller 2021); "Bayawak" in Tagalog and most local dialects.

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The Bangon Monitor Lizard was first described in 2014 as phenotypically similar, but not closely related to *Varanus marmoratus* and is assigned to subgenus *Soterosaurus* (Welton et al. 2014; Bucklitsch et al. 2016). The distinguishing features of this species are large dark spots in the gular fold (Auliya and Koch 2020), 136 ± 9 dorsal scales at mid-body and 160 ± 6 ventral scales (Welton et al. 2014). These lizards are found only on two islands: Mindoro and Semirara (Camina 2019). The insular distribution of the species is not well known (Suarez 2019), 17 specimens examined by Welton et al. (2014) from Mindoro Island were from Occidental Mindoro Province: Municipality of Sablayan, Municipality of Paluan and Municipality of San Jose; Oriental Mindoro Province: Municipality of Naujan and Mt Halcon; and only one locality from Semirara Island, Municipality of Caluya. The lizard's IUCN Red List status was recently updated from Not Evaluated (NT) to Least Concern (LC) (Cielo and Gaulke 2022).

Our report details visual encounters from the north-central Municipality of Abra de Ilog in Occidental Mindoro where observations of *Varanus bangonorum* have never been documented before. Observations in this region complete the gap in the distribution of this species on Mindoro Island. In general, observations of this monitor lizard species are rarely documented (Alviola et al. 2022).

Methods and materials

Observation area

Mindoro is the seventh largest island in the Philippines, located off the south-western coast of Luzon and north-east of Palawan and politically divided into two provinces: Occidental Mindoro and Oriental Mindoro. All our observations originate from the vicinity of Barangay Udalo, Municipality of Abra de Ilog, Province of Occidental Mindoro. The total observation area, locally known as Munting Buhangin, consists of 14.52 ha (145,200 m^2) of privately-owned real estate, subdivided into eighty residential lots and several common areas with currently fourteen finished vacation houses of various styles and sizes (Fig. 1).

Ridges with a maximum height of 155 m elevation form natural boundaries to the east, south and west; the northern border is an approximately 700-metre-long rocky coast interspersed with four beaches and coves (Suppl. material 1: fig. S1). This shoreline is closely fronted by a long stretch of coral reefs and forms part of the Verde Island Passage (or Verde Island Marine Corridor), internationally hailed as the "Center of the Center of Marine Biodiversity" (Carpenter and Springer 2005). There is no direct road access, hence no motorised traffic within this area. To protect the natural surroundings with its inhabiting wildlife, trespassing and harmful activi-

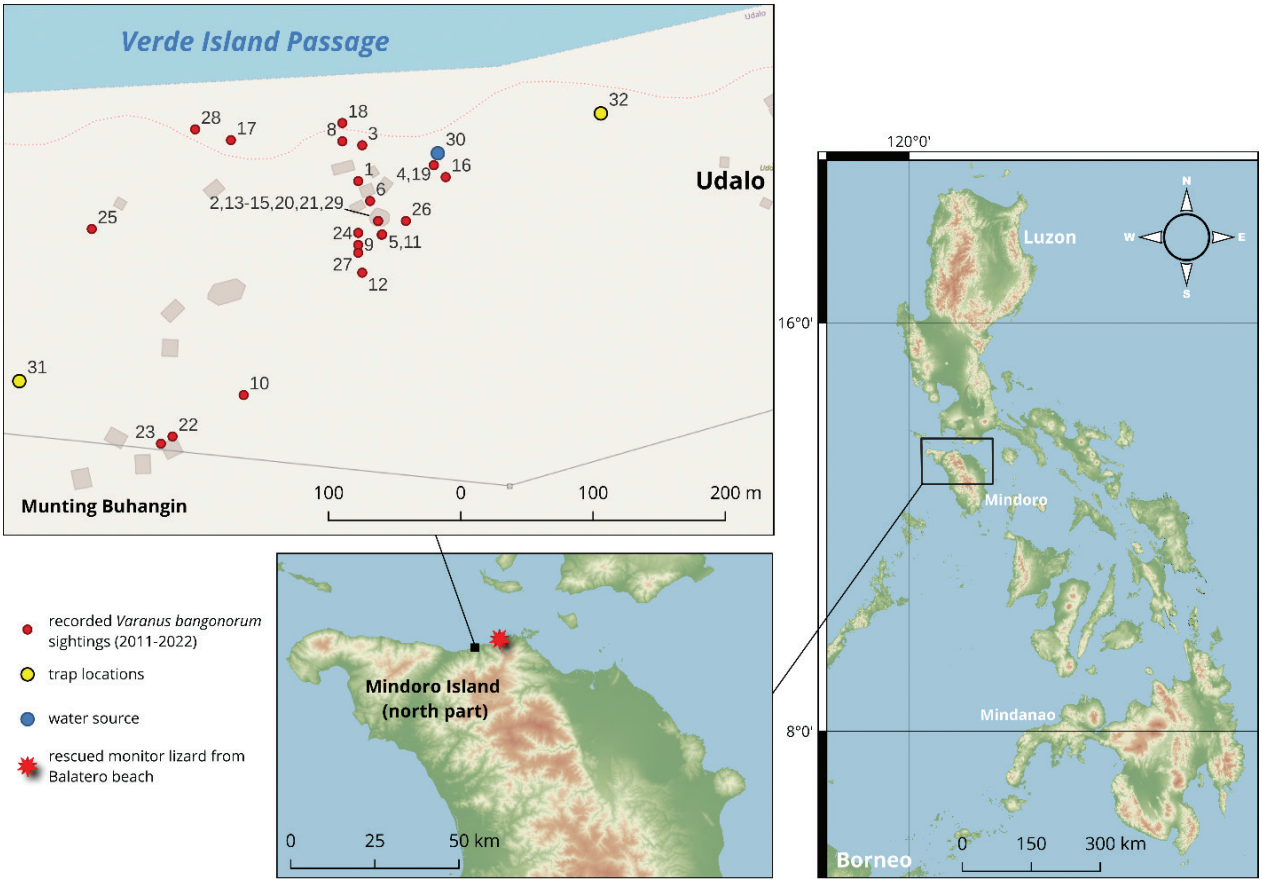

Figure 1. Map of the Philippines indicating the position of the records of *V. bangonorum*. Base maps: Open Street Map and data from http://srtm.csi.cgiar.org.

ties, including all forms of hunting, plant/fruit collection, littering, logging and kaingin (slash-and-burn), are prohibited and privately monitored within the boundaries of Munting Buhangin. Approximately three-quarters of the area has remained undisturbed since 1998, resulting in a partly very dense secondary tropical lowland forest with areas of semi-closed canopy.

Dominant flora includes members of the Dipterocarpaceae, other native non-hardwood tree and shrub species, vining plants (*Anamirta* sp.) and climbing ferns (*Lygodium* sp.) and old fruit trees (*Mangifera indica*, *Cocos nucifera*) (Suppl. material 1: fig. S2). Typical beach vegetation includes species of *Barringtonia*, *Terminalia*, *Caesalpinia* and *Ipomoea* (Primavera and Sadaba 2012).

No rivers or creeks run through the property. The only constant freshwater source is a small oval-shaped drip-catch basin of approximately 100 cm × 50 cm with a maximum depth of only 5 cm, located above one of the beaches at 31 m elevation close to the eastern boundary. Especially during the dry season, there are gatherings of Cane Toads (*Rhinella marina*) and other amphibian species. These may provide easy prey for lizards and snakes (Suppl. material 1: fig. S3).

Species observation

Our report is based on citizen-science data, contributed mainly by the co-author and collected over eleven years from 2011 to 2022. Each animal observed was photographed or video recorded; the summary includes only clearly identified records. We selected 29 clear and identified examples to represent sightings of the lizards during this period (Table 1).

We then mapped out the area, based on the sightings of *Varanus bangonorum*. Depending on the contributor, the use of recording equipment varied, mostly Panasonic DMC-TZ8 and TZ71, lately Sony RX10 IV and occasionally cell phone camera (Realme C11). We also verified the geographical coordinates of the sighting localities by using a hand-held navigator Garmin GPSmap 62s and added our corresponding field notes as a short reference (Table 1; 1–29). Coordinates and elevation for other points of interest are additionally included, for example, water sources and traps (Table 1; 30–32).

We gathered information, particularly on the local hunting methods, through informal interviews with local community members from Udalo (Tagalog) and Latag (Iraya). The interviews conducted were not standardised. The interviews did not last long, the basic questions being about the observation of monitor lizards in given locations and the attitude of the local population towards them and potential threats.

All photo- and video-graphic evidence is based on chance encounters within Munting Buhangin. We did not handle lizards for any purpose other than rescue and release (Table 1; 7, 9, 12, 13).

Table 1. Recorded sightings of *Varanus bangonorum* with geographical coordinates and field notes. Each location represents a unique sighting/individual (see Fig. 1).

Observation	Date	Latitude, Longitude	Elévation (m)	Notes
1	24-11-2011	13.477778°N, 120.816861°E	27	In-house, observation by H.D. Prüßner
2	17-02-2012	13.4775°N, 120.817°E	31	In-house, the smallest specimen
3	21-01-2012	13.478028°N, 120.816889°E	19	Resting close to the beachfront
4	20-12-2013	13.477889°N, 120.817389°E	46	Rescued from a dog attack; died later
5	02-06-2014	13.477404°N, 120.817025°E	29	Hunting and consuming insect
6	11-10-2015	13.477639°N, 120.816944°E	20	Basking next to the wall
7	16-06-2016	13.500131°N, 120.881394°E	3	Purchased from the captor and released
8	24-09-2016	13.478056°N, 120.81675°E	17	Thermoregulating ≥ 3 m above ground
9	16-09-2017	13.477417°N, 120.816861°E	30	In-house, caught and released
10	09-09-2018	13.476286°N, 120.816061°E	73	Near a residence, observation by A. Richard
11	21-05-2019	13.477406°N, 120.817028°E	19	Basking on a wooden trunk
12	23-05-2019	13.477139°N, 120.816889°E	17	In-house: 1 of 4 - caught and released
13	25-05-2019	13.4775°N, 120.817°E	31	In-house: 2 of 4 - caught and released
14	26-05-2019	13.4775°N, 120.817°E	31	In-house: 3 of 4 remained in hiding
15	28-05-2019	13.4775°N, 120.817°E	31	In-house: 4 of 4 died, no visible injuries
16	02-06-2019	13.477806°N, 120.817472°E	27	Largest specimen, digging for food
17	11-10-2019	13.478064°N, 120.815972°E	11	Beach front, foraging
18	09-03-2020	13.478183°N, 120.81675°E	7	Beach front: basking on a tree trunk, ≤ 6 m
19	13-09-2020	13.477889°N, 120.817389°E	46	Hiding amongst leaf litter in a ravine
20	18-09-2021	13.4775°N, 120.817°E	31	Near the house, sleeping in a tree
21	19-09-2021	13.4775°N, 120.817°E	31	Basking after a heavy rain > 12 hours
22	23-01-2022	13.475997°N, 120.815564°E	79	1 of 3, observation by G. Aguirre
23	12-02-2022	13.475947°N, 120.815483°E	80	2 of 3, with prey (Cane Toad)
24	10-07-2022	13.477333°N, 120.816861°E	36	In-house, help with the escape
25	27-07-2022	13.477444°N, 120.815°E	32	3 of 3, observation by N. Bandico
26	03-08-2022	13.4775°N, 120.817194°E	40	Foraging in a bush
27	11-09-2022	13.477278°N, 120.816861°E	36	Foraging in the forest litter
28	15-09-2022	13.478139°N, 120.815722°E	shore	Beachfront, hidden in the rocks
29	22-10-2022	13.4775°N, 120.816944°E	19	Observation of defecating lizard
Other relevant points				
30	Water source	13.477972°N, 120.817417°E	31	100 cm × 50 cm × 4 to 5 cm depth
31	Traps	13.476383°N, 120.814494°E	79	The western slope, dead in trap, by-catch: rodent
32	Traps	13.47825°N, 120.818556°E	30	Eastern slope, traps and spread-out fishnet

Results

Observations of *V. bangonorum*

These lizards are diurnal, leading a mixed life between terrestrial and arboreal habitats. On 18-09-2021, we observed a young individual resting and sleeping for more than 12 hours overnight, approximately two metres above the ground. It did not seek shelter from the continuous heavy rainfall (Fig. 2A, Table 1; 20 and 21). The lizards also chose higher vegetation for basking on tree trunks at three to six metres height (Fig. 2B, Table 1; 8, 18, 21, Suppl. material 1: fig. S4).

The by-far largest (estimated SVL of more than 50 cm) monitor lizard was observed for several minutes while foraging for rodents (Muridae). Using alternate movements of the front legs for digging, it expanded a hole in the ground in a slightly sloped area (Table 1; 16). Throughout this activity, the lizard constantly remained alert by frequently withdrawing its head from the hole, looking around and flicking its tongue (Suppl. material 2). This specimen's impressive size was visible when it finally ran off with a captured rodent in its snout.

The catching of the notorious invasive Cane Toads (*Rhinella marina*) was most frequently observed (Suppl. material 3). The same adult animal, distinguished by its remaining neck snare, was sighted three weeks earlier within the same observation area (Table 1; 22). The third and last encounter happened six months later when this individual was observed roaming around in a different location, still wearing the remains of the neck sling (Fig. 3, Table 1; 25).

We observed a young specimen catching and chewing on a large insect, likely a member of the order Coleoptera (Table 1; 5, Suppl. material 1: fig. S5). The unusual observation was when, after seeing the observer, the lizard squatted and then excreted faeces before disappearing into the undergrowth. A closer examination of the faeces showed chitinous insect parts' remains, suggesting that some insects' exoskeleton cannot be completely digested, confirming insectivorous behaviour amongst young individuals (Table 1; 29, Suppl. material 1: fig. S6).

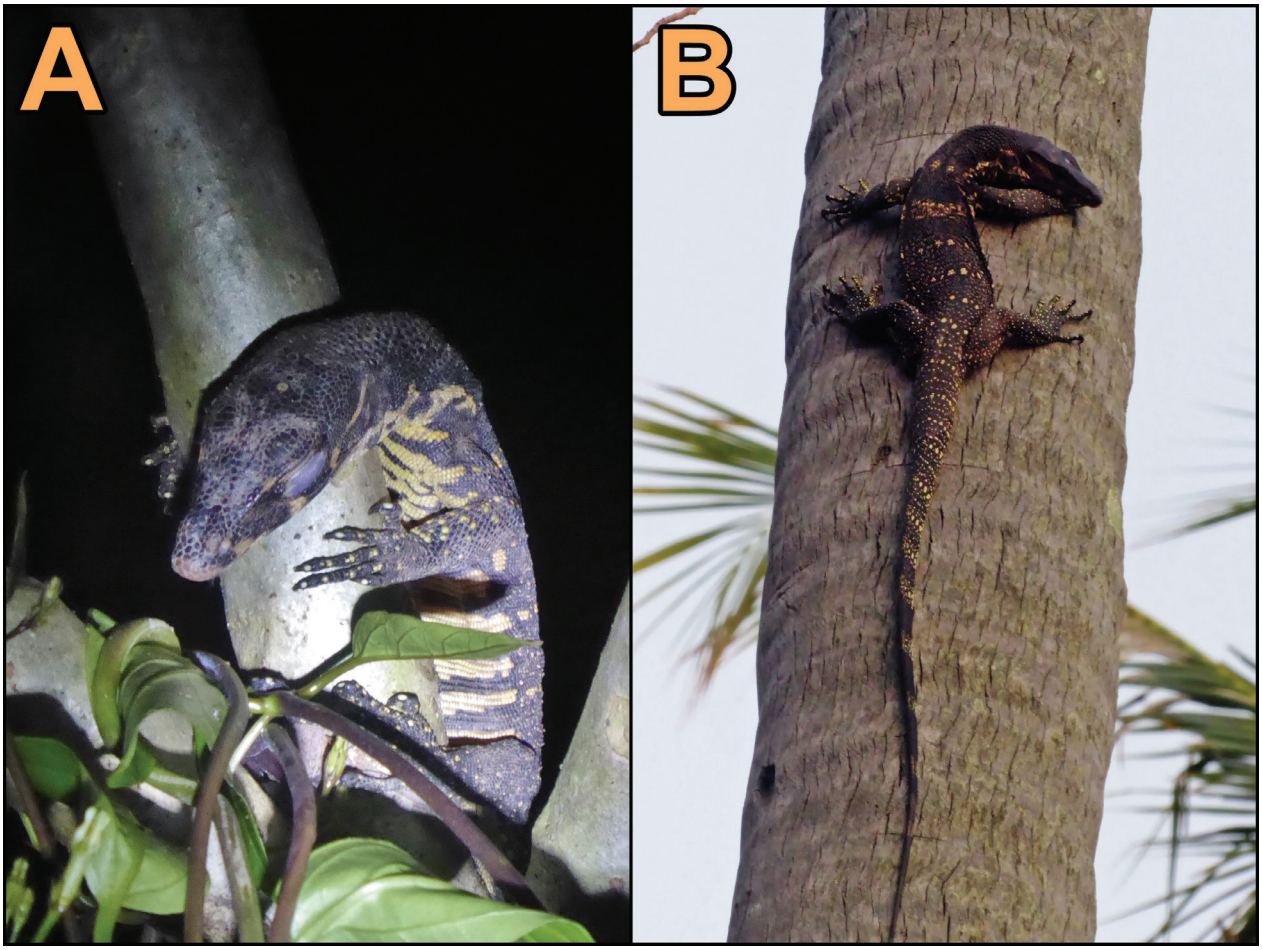

Figure 2. A. A juvenile specimen is sleeping on a shrub (*Plumeria* sp.) in a characteristic position- holding the branch close to the body, with four limbs and a tail along the tree trunk on the night of 18 September 2021 at 23:52 h.; **B.** Adult monitor lizard (Table 1; 18) basking on a palm tree trunk (*Cocos nucifera*). Photographs by Michaela S. Webb.

Figure 3. Adult lizard carrying a hunted Cane Toad (*Rhinella marina*) (12-02-2022). The same individual was observed six months later (27-07-2022). Photographs by Gerlyn D. Aguirre (left), Nhayume A. Bandico (right).

Local threats

Before description of the Mindoro endemic species *Varanus bangonorum* in 2014 (Welton et al. 2014), we observed the public trading of monitor lizards during occasional visits to Puerto Galera (a neighbouring municipality in the Province of Oriental Mindoro) between 1998 and 2002: animals were bound and hung alive from tree limbs by the roadside (Brgy. Sto. Niño; main road from Balatero pier to town proper).

The last encounter (on 16-06-2016) with a captive monitor lizard happened on the verge of departure from Balatero pier by private outrigger boat (banka) back to Munting Buhangin. We observed a person with a monitor lizard on a "leash" (a string looped around the neck) while walking with the lizard along Balatero beach. After some difficult discussions, he finally agreed to part with the animal in exchange for PHP 200 (Table 1; 7, Suppl. material 1: fig. S7).

The hunting of local Monitor Lizards is seasonal during dry months. It is done by setting different kinds of simple, yet very effective traps hidden within leaf-littered grounds. Foot and neck snares are being used to trap the lizards (e.g. Suppl. material 1: figs S8–S10). Depending on location and positioning, empty traps may be challenging to detect by the untrained eye unless the string used as a snare is of bright colour. In 2022, we successfully destroyed more than thirty traps on the Western and Eastern sloping borders at Munting Buhangin (Fig. 4, Table 1; 31 and 32).

Discussion and conclusion

Our observations confirm that *V. bangonorum* successfully hunts and feeds on invasive toads without harm (Table 1; 23, 25, Suppl. material 3). When threatened, Cane Toads release toxins from their parotid glands that may be lethal to some Varanidae species (Pettit et al. 2020, 2021a; Harvey et al. 2022), but genetic testing suggests that four varanids of the subgenera *Soterosaurus* are physiologically resistant to toad toxins (Pettit et al. 2021b).

According to a 30-year (1989–2018) review study, no online trading was traced to originate from the island of Mindoro (Sy and Lorenza II 2020). Since our single observation (Table 1; 7, Suppl. material 1: fig. S7), there are no indications yet of *Varanus bangonorum* being purposely captured for trade or trafficking, online or direct, in Munting Buhangin. The fact suggesting this state is that the seller we met was neither aware of the species' status nor the reptile's value in the pet trade at that time. In comparison, other endemic Philippine monitor lizard species are traded at up to PHP 100,000 (*Varanus bitatawa*) (Sy 2012).

Figure 4. On 27-02-2022 remains of a strangled juvenile Bangon Monitor Lizard (*Varanus bangonorum*) were discovered and removed; all traps were destroyed and snares were collected. The western slope, Munting Buhangin. Photographs by Michaela S. Webb.

Seemingly overlooked and not yet addressed are the online encouragements to hunt "Bayawak", with several YouTube channels proudly presenting trapping methods with instructions on how to prepare the monitor lizard meat for consumption (e.g. Totskey TV 2021). Although the local Tagalog regard the Bangon Monitor Lizard more as a predator than as a food source, they do not collect monitor lizards' eggs for consumption either. Our interviews include reports of these reptiles sneaking into the villages to catch young chickens or to steal eggs. The described hunting methods have gone on for decades without monitoring by the Government; at least for the indigenous people, they are integrated into their way of life. We conclude that deliberate hunting by setting traps is one of the major threats in this area and probably across the entire Philippine islands, especially as most of the captured animals appear to be young specimens.

Another threat is the irreversible loss of natural habitats through a wide range of human activities, such as development (e.g. housing, infrastructure, small-scale mining, river channelling), (illegal) logging and the expansion of slash-and-burn practices (kaingin) into more remote and previously-untouched areas (Tapper 2006; Smith et al. 2012; Wagner et al. 2015).

A possible solution might be to actively involve the local people in a long-term 'Bayawak Project' similar to 'Pawikan Patrol' - a sea turtle conservation project in Barangay Udalo (Pawikan Patrol 2022). Such a project could raise awareness and instil pride in possession and protection towards these lizards and other endemic animals instead of exploiting them. Local knowledge would be a valuable resource and contribute to further research projects. Another great example to follow is workshops regarding wildlife conservation, as presented by Bhattacharya et al. (2019), showing monitor lizards and their usefulness in the ecosystem.

Considering the observations presented herein, we strongly encourage conservationists to pay more attention to the threats to *Varanus bangonorum* (Suppl. material 1: fig. S11). Conducting observations on a broader long-term scale would help in their conservation.

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Supplementary material 1

Photographic documentation of the observations

Authors: Przemysław Zdunek, Michaela S. Webb

Data type: Adobe PDF file

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Link: https://doi.org/10.3897/herpetozoa.36.e96841.suppl1

Supplementary material 2

Large adult lizard digging in search of rodents on the slope by the forest on 02/06/2019

Authors: Przemysław Zdunek, Michaela S. Webb
Data type: MP4 file
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Link: https://doi.org/10.3897/herpetozoa.36.e96841.suppl2

Supplementary material 3

Varanus bangonorum catching an invasive Cane Toad (*Rhinella marina*)

Authors: Przemysław Zdunek, Michaela S. Webb
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