

The threat of discarded food and drinks containers to monitor lizards

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INTRODUCTION

Monitor lizards (family Varanidae) have a wide distribution in the tropics and sub-tropics including Australasia, south and south-east Asia, Africa, and the Middle East (Koch et al., 2013; Auliya & Koch, 2020). They have an important role in ecosystem as predators, scavengers, and creators of microhabitats for other animals (Doody et al., 2021). Typically, monitors are big lizards and the family includes the largest living lizard, the Komodo dragon *Varanus komodoensis* whose adult males measure up to 3.1 m and weigh up to 100 kg (Jessop et al., 2006). However, there are some small species, e.g. *Varanus sparnus* the adults of which may have a body length of only 23 cm and mass of 17 g (Koch et al., 2013; Auliya & Koch, 2020).

Only 14 of the 68 species listed by IUCN are considered to be of conservation concern although 10 other species are Data Deficient (IUCN, 2021). Currently, the major anthropogenic threats to monitor lizards include the degradation of their natural habitats, uncontrolled tourism, and pet trade (Koch et al., 2013; Zdunek, 2019; Ariefiandy et al., 2021). Locally, road mortality may also limit their populations (Hastings et al., 2019; Ayob et al., 2020). Moreover, monitor meat is traded and consumed as a novelty food, a traditional remedy for a range of ailments (skin diseases, eczema, asthma, blindness), as an aphrodisiac (Uyeda et al., 2014; Nijman, 2015; Zdunek, 2019), and there is still demand for monitor skin from the leather industry (Boscha et al., 2020). Progressive global warming may also cause a decrease in their habitat patch occupancy (Jones et al., 2020).

It is well known that many monitor lizards exploit urban habitats, especially rubbish dumps, which provide food (Kulabtong & Mahaprom, 2015; Karunarathna et al., 2017). Indeed, such littered areas are characterised by higher population abundance compared to undisturbed habitats (Uyeda, 2009; Jessop et al., 2012). Although feeding on organic waste can improve the lizards' body condition and reduce the parasite load (Jessop et al., 2012), availability of such food alters their behaviour and presents them with many threats. Association with rubbish dumps impacts some important aspect of monitor biology including - sex ratio (male-biased; Jessop et al., 2012); movement patterns by reducing species home ranges (Stanner & Mendelssohn,

1987); increased antagonistic interactions and social hierarchy (Uyeda et al., 2015); reduced offspring survival due to cannibalism or predation (Jessop et al., 2012); and reduce reproductive success due to high levels of mate competition (Jessop et al., 2012). Moreover, feeding on anthropogenic food waste can lead to internal injuries and consequently to a slow death (Trembath & Freier, 2005; Gillet & Jackson, 2010). Another, but still understudied threat is getting stuck in food or drinks containers. A monitor lizard may put its head into a container or enter it completely to eat food leftovers or other animals that got stuck therein before. However, getting the head out of the container may be a problem, and such an incident is often fatal. A recent study revealed that beside invertebrates and mammals, reptiles are quite often exposed to such danger. Among 77 reptile-container interactions, 13 (17 %) concerned monitor lizards (Kolenda et al., 2021).

Herein, we highlight the problem of discarded food/drinks containers by presenting new observations of monitor lizards that we obtained from other scientists and naturalists combined with those reported previously (Kolenda et al., 2021). Full details are presented in Supplementary Materials (Table 1S) and include a total of 32 cases of monitors stuck in discarded containers (Fig. 1). Most events occurred in Australia (18, 56 % of all cases). Observations were made on eight monitor species, of which *Varanus acanthurus* was the most common (9 cases, 28 %). None of the species observed were in an IUCN Red List threatened category although *Varanus nebulosus* and *Varanus similis* have not been evaluated. In six containers (19 %), the monitors were found dead. In the remaining 26 (81 %), they were alive at the time of observation, and at least in 22 of these cases they were rescued by an observer or transported to a wildlife rescue. The most common container in which the trapped animals were observed was drinks cans (18, 56 %), followed by food cans (12, 38 %), and a single plastic jar (3 %), and an unrecorded type of container (3 %).

Discarded containers are common litter items in terrestrial environments (Roman et al., 2020). They pose a threat to various groups of animals, including arthropods and small vertebrates as well as large animals such as ungulates, leopards or bears (Kolenda et al., 2021). By themselves mortality due to such containers would not be expected to lead to a population decline, but they constitute one of



Figure 1. Examples of monitor lizards from Australia with their heads stuck in discarded drinks cans - **A–D.** *Varanus acanthurus*, **C.** *Varanus similis*

many factors that synergistically may limit the population size, especially in urban habitats. However, in the case of the Critically Endangered Bermuda rock skink *Plestiodon longirostris*, an endemic lizard of Bermuda, discarded containers are indeed one of the main threats (Davenport et al., 2001). It should be noted that containers such as bottles or cups are also a potential trap for reptiles (for details see Figure 4a in Kolenda et al., 2021), whereas other garbage poses other direct threats to reptiles, e.g. by ingestion or entanglement (Walde et al., 2007; Strine et al., 2014).

Due to the relative rarity of the above-mentioned observations, the real impact of discarded containers on monitor populations remains poorly understood. Taking into consideration reports presented herein, we strongly encourage conservationists to pay attention to this issue. Workshops on conservation of wildlife (such as presented by Bhattacharya et al., 2019) that aim to raise public awareness should mention the harmful effects of litter on animals. Suggestions for limiting impacts should include - to

implement strict regulations regarding littering and waste disposal; to install garbage bins along hiking paths and ensure that they are emptied regularly; and, to engage local communities in rubbish clean-up actions.

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Table1S. A list of monitor lizards that were found in discarded containers, AD - adult, SUB – sub-adult, JUV - juvenile, D - dead, L - live

Species	Life stage	Dead /Live	Country	Type of container	Source/Observer
<i>Varanus acanthurus</i>	A	D	Australia	Drink can	Kolenda et al. 2021
<i>Varanus acanthurus</i>	A	L	Australia	Drink can	Kolenda et al. 2021
<i>Varanus acanthurus</i>	A	L	Australia	Drink can	Brian Bush; https://youtu.be/2cDWddRjhB0 ; access date 02.03.2021
<i>Varanus acanthurus</i>	A	L	Australia	Drink can	Ben Campbell
<i>Varanus acanthurus</i>	A	D	Australia	Drink can	Owen Gale
<i>Varanus acanthurus</i>	A	L	Australia	Drink can	Zig Madycki
<i>Varanus acanthurus</i>	A	D	Australia	Drink can	https://www.exploroz.com/OntheRoad/Environment/Care.aspx ; access date 02.03.2021
<i>Varanus acanthurus</i>	A	D	Australia	Drink can	Eidenmüller 2021
<i>Varanus acanthurus</i>	A	L	Australia	Drink can	Nicole Haigh
<i>Varanus bengalensis</i>	JUV	L	India	Drink can	https://www.youtube.com/watch?v=V9864TtY3ho ; access date 02.03.2021
<i>Varanus bengalensis</i>	A	L	India	Plastic jar	https://www.youtube.com/watch?v=NK0Yxic-8sA ; access date 02.03.2021
<i>Varanus gouldii</i>	SUB	L	Australia	Drink can	Kolenda et al. 2021
<i>Varanus gouldii</i>	SUB	D	Australia	Drink can	Kolenda et al. 2021
<i>Varanus gouldii</i> (flavirufus type)	SUB	L	Australia	Drink can	Kolenda et al. 2021
<i>Varanus gouldii</i>	SUB	L	Australia	Drink can	Owen Gale
<i>Varanus nebulosus</i>	A	L	No data	Food can	Kolenda et al. 2021

<i>Varanus nebulosus</i> *	A	L	Malay Peninsula	Food can	Kolenda et al. 2021
<i>Varanus nebulosus</i>	A	L	Malaysia	Food can	https://youtu.be/37csnfVDJxA ; access date 02.03.2021
<i>Varanus nebulosus</i>	A	L	Thailand	Food can	https://au.news.yahoo.com/monitor-lizard-helped-getting-head-120000925.html ; access date 02.03.2021
<i>Varanus nebulosus</i>	A	L	Malaysia	Food can	https://www.youtube.com/watch?v=k28heE7RBEQ ; access date 02.03.2021
<i>Varanus niloticus</i>	A	L	South Africa	Food can	Kolenda et al. 2021
<i>Varanus salvator macromaculatus</i>	A	L	Thailand	Food can	Kolenda et al. 2021
<i>Varanus salvator macromaculatus</i>	A	L	Thailand	Food can	Kolenda et al. 2021
<i>Varanus salvator macromaculatus</i>	A	D	Thailand	undetermined type	Ulysse Boiteau-Montéville
<i>Varanus salvator macromaculatus</i>	A	L	Thailand	Food can	https://www.facebook.com/watch/?v=822815378270890 ; access date 02.03.2021
<i>Varanus salvator macromaculatus</i>	A	L	Thailand	Food can	https://www.youtube.com/watch?v=RnlXy7rJ84c ; access date 02.03.2021
<i>Varanus salvator macromaculatus</i>	A	L	Thailand	Food can	https://www.facebook.com/watch/?v=1204178096408768 ; access date 02.03.2021
<i>Varanus similis</i>**	A	L	Australia	Food can	Kolenda et al. 2021
<i>Varanus similis</i>	A	L	Australia	Drink can	Paul Vandersar
<i>Varanus tristis</i>	A	L	Australia	Drink can	Kolenda et al. 2021
<i>Varanus tristis</i>	A	L	Australia	Drink can	Kolenda et al. 2021
<i>Varanus tristis</i>	A	L	Australia	Drink can	https://www.sciencesource.com/archive/Lizard-with-Head-Stuck-in-Beer-Can-SS2422609.html ; access date 02.03.2021

*initially determined as *V. komodoensis*, but after detailed inspection and consultation with an expert, we suggest it is *V. nebulosus*

**initially determined as *V. scalaris*, however, correct name is still under debate, but according to Auliya and Koch, 2020, Eidenmüller, 2021 and www.reptile-database.org/ [accessed 02-03-2021], it should probably be *V. similis*

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