

# An Annotated Bibliography of Captive Reproduction in Monitor Lizards (Varanidae: *Varanus*). Part III. *Soterosaurus*

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**Abstract:** Popular in zoos and private collections, monitor lizards have been maintained in captivity for nearly two centuries. During this time, but especially over the past three decades, a voluminous body of publications has brought to light important details and perspectives that have helped advance their captive husbandry and reproductive management. This bibliography presents an annotated compilation of publications pertaining strictly to the captive reproduction of monitor lizards belonging to the *Varanus* subgenus *Soterosaurus*, commonly known as water monitors. It is intended to serve as a guide for zoos and private herpetoculturists looking to expand their knowledge and familiarity with this group and introduce readers to different perspectives on their management and reproduction in captivity.

## Introduction

Monitor lizards have a long and fascinating history of being maintained in captivity that dates back to at least the early 19th Century. Some of the earliest published accounts of monitor lizards in captive collections reference animals held in European menageries and zoological gardens (Cox, 1831; Knight, 1867; Mitchell, 1852; Sclater, 1877), although private keepers also maintained representatives of this group during this period (Bateman, 1897; Lachman, 1899; von Fischer, 1884). Alfred “Gogga” Brown was probably the first individual to genuinely attempt to reproduce monitor lizards in captivity in the late 1800s (Branch, 1991). Although he received hundreds of eggs (from 33 clutches) from a large group of more than 40 captive *Varanus*

*albigularis* he maintained outdoors in South Africa, he was unsuccessful in hatching any live offspring (Branch, 1991). Eggs had also been received but not hatched by other keepers around this time (*e.g.*, Thilenius, 1898); these eggs were usually scattered by the females who clearly did not have appropriate conditions available for nesting (Branch, 1992; Thilenius, 1898). A poor understanding of monitor lizard biology and husbandry and reptile egg incubation undoubtedly prohibited successful captive breeding from taking place for many decades. This was especially apparent in a 1967 report by Osman (1967), who, while discussing a clutch of *V. komodoensis* eggs that were scattered across the ground of the enclosure rather than buried, suspected that the eggs were to be later buried in the sand by the female after they had been left out in the sun for the shells to

harden.

The first documented record of successful captive breeding of a monitor lizard occurred with *V. komodoensis* in 1941 (de Jong, 1944). Unknown to their caretakers, a pair of adults maintained at the Batavia Zoo since 1938 secretly nested a clutch of eggs in their exhibit which unexpectedly hatched several months later, much to the zoo's surprise. The next documented case of successful captive reproduction in monitor lizards did not occur until 1962, when a wild-caught gravid *V. albigularis* produced a clutch of eggs shortly after arriving at the San Diego Zoo, which resulted in a single hatchling (Staedeli, 1962). Several additional species were successfully bred for the first time in the 1970s (Horn, 1978; Horn & Visser, 1989), with more species hatched in the 1980s (e.g., Bredl & Horn, 1987; Bröer & Horn, 1985; Eidenmüller, 1986; Eidenmüller & Horn, 1985; Horn & Petters, 1982; Horn & Visser, 1989; Irwin, 1996; Stirnberg & Horn, 1981). From the 1990s onward, monitor lizard husbandry continued to advance rapidly, to the point where at least 53 species have now been successfully reproduced in captivity (Horn & Visser, 1997; Eidenmüller, 2007; Husband & Bonnett, 2009; Brown, 2012).

In previous bibliographic installments, I have focused on the *Varanus* subgenera *Odatria*, *Empagusia* and *Phillipinosaurus* and the *V. prasinus* complex belonging to the subgenus *Euprepiosaurus* (Mendyk, 2015, 2016, 2017). Here, the focus is directed towards species belonging to the subgenus *Soterosaurus*, and more specifically the *V. salvator* species complex; otherwise known as water monitors. This group is currently comprised of nine semi-aquatic species that are distributed throughout southern and Southeast Asia, and numerous islands throughout the Indo-Australian Archipelago. Although a Sri Lankan *V. salvator* currently holds the record for the longest lizard ever recorded, at 3.21 m in total length (Randow, 1932), *V. komodoensis* regularly reaches larger sizes and proportions. Still, members of the *V. salvator* complex rank among the largest lizards in the world, and are certainly the most commonly kept of the giant monitor species. Several species belonging to this group including *V. salvator*, *V. cumingi*, *V. nuchalis*, *V. togianus* and *V. marmoratus* have been maintained in captive collections; however, documented cases of successful captive reproduction are known only for two species: *V. salvator* and *V. cumingi*. The following bibliography, which represents a continuation of what will be several installments on the captive breeding of monitor lizards, focuses chiefly on water monitors

belonging to the subgenus *Soterosaurus*. Similar works that address other subgenera are forthcoming.

### Using this Bibliography

This bibliography covers all aspects of captive reproduction including both successful and unsuccessful attempts. It is largely intended to serve as a resource for zoo professionals and private herpetoculturists working with these species in captivity, but may also prove valuable to conservation biologists, ecologists, veterinarians and general enthusiasts seeking to gain familiarity with existing literature on the reproductive biology of monitor lizards. Species covered in this bibliography are organized alphabetically, with annotations describing the nature and content of each work appearing inside brackets after each reference.

Increased interest in the taxonomy and systematics of the *V. salvator* complex over the past decade has led to various taxonomic revisions of the complex (Koch *et al.*, 2007; Welton *et al.*, 2013) as well as the description of several new species and subspecies (Koch & Böhme, 2010; Koch *et al.*, 2010; Welton *et al.*, 2014). Therefore, although best efforts were made to properly assign each publication to the appropriate taxon, due to limited information, it is possible that some accounts listed for one species may represent that of another.

While best efforts were made to document all known publications relevant to the reproduction of these species in captivity, I recognize the possibility and likelihood that some publications may have been missed. Given that bibliographies are perpetual works in progress, I welcome and encourage feedback on publications missing from this bibliography and new accounts as they are published so that they can be added to an updated version of this document in the future.

**Acknowledgments** – This bibliographic series is dedicated to the late Mark K. Bayless, whose many contributions to the study of monitor lizards have helped advance the fields of monitor lizard biology and captive husbandry, inspire a new generation of enthusiasts, and stimulate new research on this group, including the present bibliography. I am indebted to Kristen Bullard, Richard Green, Michael Hardy, and Polly Lasker of the Smithsonian Institution Libraries for their assistance with sourcing obscure literature, and would also like to thank Ben Aller for allowing access to Mark Bayless's former library of monitor literature.

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### ***Subgenus: Soterosaurus***

#### ***Varanus salvator***

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*Varanus salvator macro-maculatus*. Bangkok, Thailand. Photographed by Robert W. Mendyk

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*Varanus cumingi*

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*Varanus cumingi*. Captive. Photographed by John Ad-ragna.