

An Annotated Bibliography of Captive Reproduction in Monitor Lizards (Varanidae: *Varanus*). Part II. *Empagusia* and *Philippinosaurus*

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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* subgenera *Empagusia* and *Philippinosaurus*. 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. 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 a previous bibliographic installment (Mendyk, 2016), I focused on the predominately Australian *Varanus* subgenus *Odatria*, a group that is well-represented in zoos and private collections. Here, the focus is shifted to South and Southeast Asia and its offshore islands, which are home to several endemic subgenera that are also maintained in captive collections, albeit not as frequently or abundantly as *Odatria*. Two subgenera which will be focused on in this installment are *Empagusia*, a group comprised of four species (*V. bengalensis*, *V. dumerilii*, *V. flavescens* and *V. rudicollis*) occurring throughout southern and southeastern Asia and the Malay Archipelago, and *Philippinosaurus*, a group comprised of three frugivorous species endemic to the Philippines (of which only one species has been kept and bred in captivity – *V. olivaceus*). Unlike *Odatria*, for which virtually all specimens presently maintained in captivity are captive-bred in origin, most captive individuals belonging to *Empagusia* and *Philippinosaurus* are of wild-caught origin, denoting the rarity of captive breeding among these two groups.

The following bibliography, which represents a continuation of what will be several installments on the captive breeding of monitor lizards, focuses chiefly on the subgenera *Empagusia* and *Philippinosaurus*. 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.

It should be noted that there still remains disagreement within the scientific community regarding the taxonomy of *V. bengalensis nebulosus*, particularly whether it constitutes a distinct species as proposed by Böhme & Ziegler (1997). For this bibliography, I follow the taxonomy proposed by Mertens (1942) and identify the taxon at the subspecies level. Given this taxonomic flux and the associated confusion it has created, it is possible, and perhaps inevitable, that the true taxonomic identities of taxa reported on in older publications may be unclear – whether *V. b. bengalensis* or *V. bengalensis nebulosus*. Nevertheless, the biological similarities between both subspecies suggest that reproductive data and information presented for one should be just as relevant and applicable to the other.

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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- Stirnberg, G.E. & H.-G. Horn. 1981. Eine unerwartete Nachzucht im Terrarium: *Varanus (Odatria) storri*. *Salamandra* 17(1/2):55–62.
- Horn, H.-G. 1978. Nachzucht von *Varanus gilleni* (Reptilia: Sauria: Varanidae). *Salamandra* 14(1): 29–32.
- Horn, H.-G. & G. Petters. 1982. Beiträge zur Biologie des Rauh nackenwarans, *Varanus (Dendrovaranus) rudicollis* Gray. *Salamandra* 18(1/2): 29–40.
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- von Fischer, J. 1884. *Das Terrarium, seine Bepflanzung und Bevölkerung: ein Handbuch für Terrarienbesitzer und Tierhändler*. Mahlau & Waldschmidt, Frankfurt a.M.. 384 pp.

Subgenus: *Empagusia*

Varanus bengalensis

- Ahsan, M.F. & M.A. Saeed. 2004. Some aspects of breeding biology of the Bengal lizard (*Varanus bengalensis*) in Bangladesh. *Asiatic Herpetological Research* 10: 236–240. [describes efforts to farm the species in Bangladesh and presents breeding info and reproductive data]
- Anonymous. 1981. Common monitor hatching at Madras Snake Park. *Hamadryad* 6(3): 10. [briefly documents successful reproduction]
- _____. 1982. Species of wild animals bred in captivity during 1980 and multiple generation captive births. *Reptiles. International Zoo Yearbook* 22: 367–371. [documents successful reproduction]
- _____. 1983. Species of wild animals bred in captivity during 1981 and multiple generation captive births. *reptiles. International Zoo Yearbook* 23: 267–272. [documents successful reproduction]
- _____. 1990. Huevos *bengalensis*. *Varanews* 1(1): 5. [documents egg laying]
- _____. 1991. Huevos *bengalensis* revisited. *Varanews* 1(4): 8. [documents inviable eggs]
- Bayless, M.K. 1997. Increases in breeding. *Varanids* 1(1): 3. [documents successful cases of reproduction]
- Bennett, D. 1997. *Varanus bengalensis*, the Bengal or clouded monitor. *Reptilian* 5(1): 47–56. [briefly mentions captive breeding at Honolulu Zoo]
- _____. 1998. *Monitor Lizards: Natural History, Biology and Husbandry*. Edition Chimaira, Frankfurt am Main. 352 pp. [provides general breeding information and documents successful cases of reproduction]
- D'Abreu, E.A. 1932. Notes on monitor lizards. *Journal of the Bombay Natural History Society* 36(1): 269–270. [documents egg laying taking place over several days, unsuccessful hatching]
- Deraniyagala, P.E.P. 1958. Reproduction in the monitor lizard *Varanus bengalensis* (Daudin). *Spoila Zeylanica* 28: 161–166. [describes hatching and artificial incubation of eggs collected from the wild]
- Gorman, D. 1993. Breeding the Bengal monitor in captivity. *Varanews* 3(4): 2. [describes successful captive reproduction]
- _____. 1997. Reproduction of the Bengal monitor lizard, *Varanus bengalensis*, in captivity. *Varanids* 1(2): 8–12. [describes successful captive reproduction]
- Horn, H.-G. & G.J. Visser. 1989. Review of reproduction of monitor lizards *Varanus* spp. in captivity. *International Zoo Yearbook* 28: 140–150. [presents reproductive data]
- _____ & _____. 1997. Review of reproduction of monitor lizards *Varanus* spp. in captivity II. *International Zoo Yearbook* 35: 227–246. [presents reproductive data]
- Huff, T.A. 1986. Monitor madness chapter 2: Murder and mayhem. *The Herpetoculturist* 1(2): 15–19.



Fig. 1. - Illustration of "*Tupinambis cepedien*" (= *Varanus bengalensis*). From: Daudin, F.M. 1802. *Histoire Naturelle, Générale et Particulière des Reptiles. Tome Troisième*. De l'Imprimerie de F. Dufart, Paris.

- [describes receiving eggs, but consumed by adults]
 Kellough, R. 1990. Finally, Bengal monitor eggs! Scales and Tales 4(4): 1. [documents egg laying in captivity]
 Klag, K. & H. Kantz. 1988. Bemerkungen zur Haltung und Fortpflanzung von *Varanus bengalensis bengalensis* im der Terrarium. Herpetofauna (Weinstadt) 10(52): 21–24. [describes successful captive reproduction]
 Latyshev, V.A. 1996. Some data on the reproduction of the Bengal monitor lizard *Varanus bengalensis* (Daudin) in the Moscow Zoo. Scientific Research in Zoological Parks 6: 51–54. [describes successful captive reproduction (*In Russian*)]
 Mendyk, R.W. 2012. Reproduction of varanid lizards (Reptilia: Squamata: Varanidae) at the Bronx Zoo. Zoo Biology 31(3): 374–389. [presents reproductive data]
 Misra, P.L. 1960. A note on the common monitor, *Varanus monitor* Linn. Journal of the Bombay



Fig. 2. Illustration of “*Monitor dumerilii*” (= *V. dumerilii*). From: Müller, S. & H. Schlegel. 1839-1844. Reptilia. 72 pp. + 10 pl. In: Temminck, C.J. (ed.), Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche overzeesche bezittingen Lithogr. Instituut van A. Arnz & Co., Leiden.

- Natural History Society 57(3): 669–670. [documents egg laying, but unsuccessful hatching]
 Petzold, H.-G. 2008. The Life of Captive Reptiles. Contributions to Herpetology, Volume 22. Society for the Study of Amphibians and Reptiles, Ithaca. 275 pp. [briefly mentions nesting behavior]
 Rehák, I. 1991. Herpetology and herpetoculture in Czechoslovakia. Pp. 74–84. In: Zulich, A.W. (ed.), Proceedings of the 14th International Symposium on Captive Propagation & Husbandry. International Herpetological Symposium, Dallas and Fort Worth. [briefly documents successful reproduction]
 Sprackland, R.G. 1989. Mating and waiting: a status report on reproduction in captive monitor lizards (Sauria:Varanidae). Pp. 57–63. In: Gowen, R.L. (ed.), Captive Propagation and Husbandry of Reptiles and Amphibians. Special Publication #5. Northern California Herpetological Society. [presents reproductive data]
 van der Koore, J. 1989. Kweek met varanen van 1966-1987. Lacerta 47(4): 106–107. [briefly mentions successful reproduction at Honolulu Zoo]
 Wonosasmito, B. 2009. *Varanus nebulosus* (Gray, 1831). Bulletin de liason du G.E.V. 1(1): 21. [describes successful captive reproduction]
 Zheng-qiangl, X., Y. Yao-hual, C. Zhi-bingl, Z. Weil, C. Junl, W. Wei-chunl & S. Yi-xuan. 2010. Some reproductive characteristics of *Varanus bengalensis* in captivity. Sichuan Journal of Zoology 29(1): 70–72. [presents reproductive data]

Varanus dumerilii

- Aller, B. 2014. On the cover: *Varanus dumerilii*. Biawak 8(1): 1–2. [photographic documentation of successful reproduction]
 — & M. Manago. 2009. Breeding and reproduction of *Varanus dumerilii*. Pp. 264–265. In: Sprackland, R.G., Giant Lizards. 2nd Ed. TFH Publications, Neptune. [describes successful reproduction in a private collection]
 Anonymous. 1997. Species of wild animals bred in captivity during 1994 and multiple generation captive birds. Reptiles. International Zoo Yearbook 35(1): 354–362. [documents successful reproduction at Birmingham Zoo]
 Balsai, M.J. 1996. Natural history and captive husbandry of selected monitor species. Reptiles USA Annual 1996: 136–153. [documents

- successful reproduction at Zoo Atlanta]
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- ____. 1998. Monitor Lizards: Natural History, Biology and Husbandry. Edition Chimaira, Frankfurt am Main. 352 pp. [reviews general breeding information]
- Card, W.C. 1995. North American Regional Asian Forest Monitor Studbook. Dallas Zoo, Dallas. 79 pp. [documents successful captive reproduction in North American zoos]
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- Hartdegen, R.W. 2000. 1999 Asian Forest Monitor North American Regional Studbook. Dallas Zoo, Dallas. 144 pp. [documents successful captive reproduction in North American zoos]
- ____. 2002. 2002 Asian Forest Monitor North American Regional Studbook. Dallas Zoo, Dallas. 123 pp. [documents successful captive reproduction in North American zoos]
- Hauschild, A. 1998. Haltung und Nachzucht des Dumeril-Warans, *Varanus dumerilii* (Schlegel, 1839). Herpetofauna (Weinstadt) 20(115): 27–34. [describes successful reproduction]
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- _____. 1995. Dumeril's monitor lizard. *Reptiles* 3(7): 56–69. [briefly mentions successful reproduction in zoos and private collections]

Varanus flavescens

- Berker, M. 1992. Translation of: Visser, G.J. 1985. Notes on the breeding biology of the yellow monitor *Varanus (Empagusia) flavescens* (Hardwicke & Gray, 1827) in the Rotterdam Zoo (Sauria: Varanidae). *Salamandra* 21(2/3): 161–168. *Varanews* 2(3): 2–5. [describes successful reproduction at Rotterdam Zoo]
- Horn, H.-G. & G.J. Visser. 1989. Review of reproduction of monitor lizards *Varanus* spp. in captivity. *International Zoo Yearbook* 28: 140–150. [presents reproductive data]
- ____ & ____ 1991. Basic data on the biology of monitors. Pp. 176–187. *In*: Böhme, W. & H.-G. Horn (eds.), *Advances in Monitor Research*, *Mertensiella* 2. Deutsche Gesellschaft für Herpetologie und Terrarienkunde e.V., Rheinbach. [presents reproductive data]
- van der Koore, J. 1988. De kweek van varanen in gevangenschap. *Lacerta* 47(2): 35–39. [discusses successful captive reproduction at Rotterdam Zoo]
- Visser, G.J. 1992. Notes on the breeding biology of the yellow monitor *Varanus (Empagusia) flavescens* (Hardwicke & Gray, 1827) in the Rotterdam Zoo (Sauria: Varanidae). *Varanews*

2(3): 2–5. [an English translation of Visser, 1985 describing successful reproduction at Rotterdam Zoo]

- _____. 1996. Waranhaltung und Zucht im Zoo Rotterdam/Niederlande. *Monitor* 4(2): 27–31. [briefly mentions successful reproduction at Rotterdam Zoo]
- _____. 2003. Herpetology at the Rotterdam Zoo. *Herpetological Review* 34(1): 11–16. [briefly mentions successful reproduction at Rotterdam Zoo]
- _____. 1985. Notizen zur Brutbiologie des Gelbwarans *Varanus (Empagusia) flavescens* (Hardwicke & Gray, 1827) im Zoo Rotterdam. *Salamandra* 21(2/3): 161–168. [describes successful reproduction at Rotterdam Zoo]

Varanus rudicollis

- Anonymous. 1990. Species of wild animals bred in captivity during 1988/1989 and multiple generation births. *Reptiles*. *International Zoo Yearbook* 30: 326–342. [documents successful reproduction in zoos]
- _____. 1991. Reptiles bred in captivity and multiple generation births. *International Zoo Yearbook* 30: 326–342. [documents successful reproduction at Fort Worth Zoo]
- Bayless, M. K. 1993. Reproductive notes on the black roughneck monitor lizard (*Varanus rudicollis* Gray, 1845). *Varanews* 3(2): 3. [discusses egg laying at Fort Worth Zoo]
- _____. 1997. The rough-neck monitor lizard (*Varanus rudicollis*). *Bulletin of the Chicago Herpetological Society* 32(12): 250–252. [documents cases of successful reproduction]
- _____. 2001. The black roughneck monitor: Malaysia's tree lizard. *Reptile and Amphibian Hobbyist* 6(9): 8–16. [documents cases of successful reproduction]



Fig. 3. Illustration of “*Monitor flavescens*” (= *V. flavescens*). From: Gray, J.E. 1833–134. *Illustrations of Indian Zoology*. Volume II. Adolphus Richter and Co., London.

- Bennett, D. 1993. A review of some literature concerning the rough-necked monitor lizard *Varanus rudicollis*. *Reptilian* 1(9): 7–10. [reviews captive breeding information]
- _____. 1998. *Monitor Lizards: Natural History, Biology and Husbandry*. Edition Chimaira, Frankfurt am Main. 352 pp. [reviews captive breeding information]
- _____. 2004. *Varanus rudicollis*. Pp. 230–233. *In*: Pianka, E.R., D.R. King & R.A. King (eds.), *Varanoid Lizards of the World*. Indiana University Press, Bloomington. [presents reproductive data]
- Card, W. 1995. Monitor lizard husbandry. *Bulletin of the Association of Reptilian and Amphibian Veterinarians* 5(3): 9–17. [provides general breeding information]
- _____. 1995. *North American Regional Asian Forest Monitor Studbook*. Dallas Zoo, Dallas. 79 pp. [documents successful reproduction in North American zoos]
- Eidenmüller, B. 2007. *Monitor Lizards: Natural History, Captive Care & Breeding*. Edition Chimaira, Frankfurt am Main, 176 pp. [provides general breeding information]
- Hartdegen, R. 1998. Black rough-necked monitors (*Varanus rudicollis*). *Reptiles* 6(10): 68–75. [provides general breeding information]
- _____. 2000. *1999 Asian Forest Monitor North American Regional Studbook*. Dallas Zoo, Dallas. 144 pp. [documents successful reproduction in North American Zoos]
- _____. 2002. *2002 Asian Forest Monitor North American Regional Studbook*. Dallas Zoo, Dallas. 123 pp. [documents successful reproduction in North American Zoos]
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- _____ & G.J. Visser. 1989. Review of reproduction of monitor lizards *Varanus* spp. in captivity. *International Zoo Yearbook* 28: 140–150. [presents reproductive data]
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- _____ & _____. 1997. Review of reproduction of monitor lizards *Varanus* spp. in captivity II. *International Zoo Yearbook* 35: 227–246. [presents reproductive data]
- Hudson, R., A. Alberts, S. Ellis & O. Byers. 1994. *Conservation Assessment and Management Plan for Iguanidae and Varanidae*. Aza Lizard Taxon Advisory Group & IUCN/SSC Conservation Breeding Specialist Group, Apple Valley. 247 pp. [briefly documents cases of successful reproduction]
- Kirschner, A., T. Müller & H. Seufer. 1996. *Faszination Warane*. Kirschner & Seufer Verlag, Keltern-Weiler. 254 pp. [provides general breeding information]
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