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*The Southeast Asia and Indo-Australian archipelago holds 60% of the varanid global diversity. The major threats to varanids in this region include habitat destruction, international commercialism, and human consumption.*

## Pressing Problems: Distribution, Threats, and Conservation Status of the Monitor Lizards (Varanidae: *Varanus* spp.) of Southeast Asia and the Indo-Australian Archipelago

Monograph 3.

André Koch, Thomas Ziegler, Wolfgang Böhme, Evy Arida and Mark Auliya

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DISTRIBUTION, THREATS, AND CONSERVATION STATUS OF THE  
MONITOR LIZARDS (VARANIDAE: *VARANUS* SPP.) OF SOUTHEAST  
ASIA AND THE INDO-AUSTRALIAN ARCHIPELAGO**

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**Abstract.**—We update an earlier review (Mertens 1959) of the monitor lizards of Southeast Asia and the Indo-Australian Archipelago, emphasizing the importance of this island region as a center of varanid diversity and endemism. Currently, 44 monitor lizard species (i.e., 60% of the known global varanid diversity) are recognized from this vast study region. New Guinea and the surrounding offshore islands harbor the highest diversity in terms of species (15) and subgenera (four). We provide a detailed identification key to all monitor lizards found in the study area. Moreover, we critically review the conservation status of all monitor lizard species involved as needed in light of urgent conservation issues. Major threats to monitor lizards include: (1) habitat destruction; (2) the international trade in reptile skins and in monitors as pets; and (3) human consumption. Current export figures of seven focal monitor species (i.e., *Varanus beccarii*, *V. boehmei*, *V. macraei*, *V. melinus*, *V. prasinus*, *V. salvator*, and *V. yuwonoi*) of the commercial skin and pet trade reflect export allowances that are not based on sound information from population studies, meaning that current harvest levels may be unsustainable and could threaten the viability of these Indonesian island endemics. Therefore, these monitor lizard species require special attention by the relevant authorities and conservationists of both the source and the consuming countries. The conservation status of all monitor lizard species and their assessment in the International Union for Conservation of Nature (IUCN) Red List is in need of a critical update and we strongly recommend the establishment of an IUCN Species Survival Commission (SSC) Monitor Specialist Group. Therefore, this review of distribution, threats, and conservation status of Southeast Asian and Indo-Australian monitor lizards is intended to support customs officers and other government agents in: (1) more strictly enforcing the regulations of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); (2) monitoring trade activities, annual harvest levels, and export quotas; (3) in reducing current unsustainable harvest levels; and, (4) in reducing over-exploitation and extinction risks of *Varanus* spp. in the wild.

**Key Words.**—conservation status; deforestation impact; Indonesia; New Guinea; Philippines; species diversity; trade impact;

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## INTRODUCTION

Monitor lizards of the family Varanidae represent an ancient group of anguimorph reptiles. Next to crocodiles and pythons, they comprise the largest living poikilothermic predators on our planet. Monitor lizards inhabit Africa, the Arabian Peninsula, the Middle East as well as South and Southeast Asia. They also inhabit the Indo-Australian Archipelago, including Australia and several remote Pacific island groups (such as the Solomons, Admiralties, and Marianas). Although they are morphologically uniform, monitor lizards show remarkable differences in body size ranging from a mere 20 cm to more than 3 m in total length (Mertens 1942; Pianka and King 2004). The closest extant relatives of varanids are the rare Bornean Earless Monitor (*Lanthanotus borneensis*) and the Chinese Crocodile Lizard (*Shinisaurus crocodilurus*; Ast 2001; Hedges and

Vidal 2009; Vidal et al. 2012). Despite enormous differences in morphology and ecology (terrestrial, arboreal, and aquatic habits), all recent monitor lizard species are still classified in the single genus *Varanus* Merrem, 1820, whose monophyly has been supported by several morphological (Branch 1982; Böhme 1988a; Becker et al. 1989; Card and Kluge 1995), and molecular genetic approaches (Baverstock et al. 1993; Fuller et al. 1998; Ast 2001). Ecologically, monitor lizards show a wide variety of adaptations. While most species are terrestrial, the New Guinean tree monitor lizards of the *V. prasinus* species group are highly arboreal and probably rarely visit the forest floor. Other species, such as the Southeast Asian water monitors of the *V. salvator* complex, display semi-aquatic to terrestrial life habits and are always associated with aquatic environments. Most monitor lizard species are carnivores or scavengers. However, a small radiation of endemic frugivorous varanids in

**TABLE 1.** Historical increase of global monitor lizard (*Varanus* spp.) diversity as compared with the number of species recognized from Southeast Asia and the Indo-Australian Archipelago, with percentages in brackets. Note the significant increase for the study area since around the turn of the 20<sup>th</sup> Century due to numerous new species descriptions and the elevation of several subspecies to full species status.

Number of monitor lizard species recognized	Author(s), year	Reference
1/0 (0%)	Linné (1766)	Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. 12th Edition. Salvius, Holmiæ [Stockholm], Sweden.
9/2 (22%)	Daudin (1802)	Histoire naturelle, générale et particulière des Reptiles. Tome troisième. F. Dufart, Paris, France.
12/6 (50%)	Duméril and Bibron (1836)	Erpétologie générale ou Histoire naturelle complète des Reptiles. Vol. III. Librairie Encyclopédique de Roret, Paris, France.
27/16 (59%)	Boulenger (1885)	Catalogue of the Lizards in the British Museum (Natural History) Volume II. Iguanidae, Xenosauridae, Zonuridae, Anguidae, Anniellidae, Helodermatidae, Varanidae, Xantusidae, Teiidae, Amphisbaenidae. Taylor and Francis, London, UK.
24/13 (54%)	Mertens (1942)	Die Familie der Warane. Abhandlungen der Senckenbergischen naturforschenden Gesellschaft 462:1–116; 465:117–234; 466:235–391.
30/14 (46%)	Mertens (1959, 1963)	Liste der Warane Asiens und der Indo-australischen Inselwelt mit systematischen Bemerkungen. Senckenbergiana Biologica 40:221–240. Liste der rezenten Amphibien und Reptilien: Helodermatidae, Varanidae, Lanthanotidae. Pp. 1–26 In Das Tierreich. Mertens, R., and W. Hennig (Eds.). Walter de Gruyter and Co., Berlin, Germany.
47/18 (38%)	Böhme (1997)	Robert Mertens' Systematik und Klassifikation der Warane: Aktualisierung seiner 1942er Monographie und eine revidierte Checkliste. Pp. I–XXII In Die Familie der Warane (Varanidae). Erster bis dritter Teil von Robert Mertens. Mertens, R. Edition Chimaira, Frankfurt a.M., Germany.
58/29 (50%)	Böhme (2003)	Checklist of the living monitor lizards of the world (family Varanidae). Zoologische Verhandlungen 341:3–43.
73/44 (60%)	Koch et al. (2010a), this study	Updated checklist of the living monitor lizards of the world (Squamata: Varanidae). Bonn Zoological Bulletin 57:127–136.

the Philippines has resulted in the evolution of *V. olivaceus*, *V. mabitang*, and the recently described *V. bitatawa*. In general, however, our knowledge about the biology of many monitor lizard species is still very limited, particularly for those species inhabiting New Guinea and the remote Pacific island groups.

**Increase of Southeast Asian and Indo-Australian monitor lizard diversity: a historical perspective.**—

Today, more than 70 species of monitor lizards are known to science (Böhme 2003; Koch et al. 2010a). Although varanids form a relatively small lizard group compared with other squamates (such as geckos or skinks), even this moderate number of species was only reached after nearly 250 years of scientific discoveries and progress (Table 1). Since Linné (1758) published his “Systema Naturae,” the number of recognized species has only slowly increased. The 12th edition (Linné 1766) of this important work for zoological nomenclature contained the first valid description of a monitor lizard species (ICZN 1959; Mertens 1946, 1956), viz. *Lacerta nilotica* (= the African *Varanus niloticus*). The first comprehensive revision of monitor lizards was published by Daudin (1802), who erected the mixed genus *Tupinambis* for monitor lizards and South American teiids. Therein, Daudin (1802) described two well-known and widespread Asian and Indo-Australian monitor lizard species: *Tupinambis indicus* (= *V. indicus*), the Pacific

Monitor, and *T. bengalensis* (= *V. bengalensis*), the Bengal Monitor. In total, seven distinct varanid species were listed by Daudin (plus two additional species that represented *V. bengalensis* and *V. niloticus* named twice under different names). Some 30 years later in their “Erpétologie générale,” Duméril and Bibron (1836) distinguished 12 monitor lizard species, six of which (*V. timorensis*, *V. bengalensis*, *V. nebulosus*, *V. piquotii* [= *V. flavescens*], *V. chlorostigma* [= *V. indicus*], and *V. bivittatus* [= *V. salvator bivittatus*]) were reported from Asia and the Indo-Australian Archipelago. Later, Müller and Schlegel (1845) provided the first account exclusively devoted to the monitor lizards of present-day Indonesia, the former Dutch colonies. They treated five species in detail: *Monitor bivittatus* (= *V. salvator*), *M. chlorostigma* (= *V. indicus*), and *M. timoriensis* (= *V. timorensis*) as well as *M. Dumerilii* (= *V. dumerilii*) and *M. prasinus* (= *V. prasinus*) Schlegel 1837-44). In addition, these authors mentioned the description of *V. marmoratus* from the Philippines. Another 40 years later, the total species number more than doubled when Boulenger (1885) listed 27 monitor lizard species (without any subspecies) in his well-known “Catalogue of the lizards in the British Museum,” containing 16 Asian and Indo-Australian species. In Mertens’ (1942) classical monograph “Die Familie der Warane,” only 24 monitor lizard species were proposed, but this

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included 31 subspecies. Thirteen of these species (seven monotypic species and six polytypic species with a total of 17 subspecies) were known from Asia and the Indo-Australian Archipelago. Twenty years later, his revised global checklist contained 30 species with 39 subspecies (Mertens 1963). Earlier, Mertens (1959) had listed 14 monitor lizard species (six monotypic species and eight polytypic species including 23 subspecies) from the Southeast Asian and Indo-Australian Archipelago area that is the focus of this update. Böhme (1997) and Ziegler and Böhme (1997) provided an update of Mertens' (1942, 1963) earlier contributions, each listing 47 monitor lizard species (37 monotypic species and 10 polytypic species including 30 subspecies). Böhme (2003) in his "Checklist of the living monitor lizards of the world" listed 58 species of monitor lizards, with 29 (26 monotypic species and only three polytypic species with 11 subspecies) inhabiting continental Southeast Asia and the Indo-Australian region. Finally, Eidenmüller and Philippen (2008) gave one of the most recent accounts of varanid lizards. These authors provided distribution maps and photographs for 67 species, more than 50% of which (i.e., 38 species including only seven subspecies) occur in our study area. Apparently, a general historical trend in monitor lizard taxonomy occurred that led to a shift in taxon numbers from 19<sup>th</sup> Century authors (who only listed species; e.g., Duméril and Bibron 1836; Boulenger 1885) to 20<sup>th</sup> Century authors (who applied a detailed subspecies concept; e.g., Mertens 1942, 1963), and reverting to a preference for full species categories by early 21<sup>st</sup> Century scientists (e.g., Ziegler and Böhme 1997; Böhme 2003). No matter which species concept dominated over the centuries, the total number of monitor lizard taxa experienced a steady increase.

The year 2010, the International Year of Biodiversity, saw a proliferation of knowledge of monitor lizard diversity. Thus, the discovery of four new species and one new subspecies from Indonesia and the Philippines alone were published in the first six months of 2010 (Koch et al. 2010b; Weijola and Sweet 2010; Welton et al. 2010). Another unrecognized subspecies of *V. salvator* from the Moluccas was described at the end of 2010 (Koch and Böhme 2010). In total, 10 new *Varanus* species and two subspecies have been introduced to science since 2003 (Koch et al. 2010a). Additionally, five taxa (*beccarii*, *cumingi*, *marmoratus*, *nuchalis*, and *togianus*) were elevated to full species status and one subspecies (*macromaculatus*) was revalidated in this short period. This represents a 20% net increase of species. Nine of these novel monitor lizard species (i.e., 90%) and the two subspecies were described from the islands of the Indo-Australian Archipelago. Only one new species of monitor lizards, *V. bushi*, was recently described from Australia (Aplin et al. 2006),

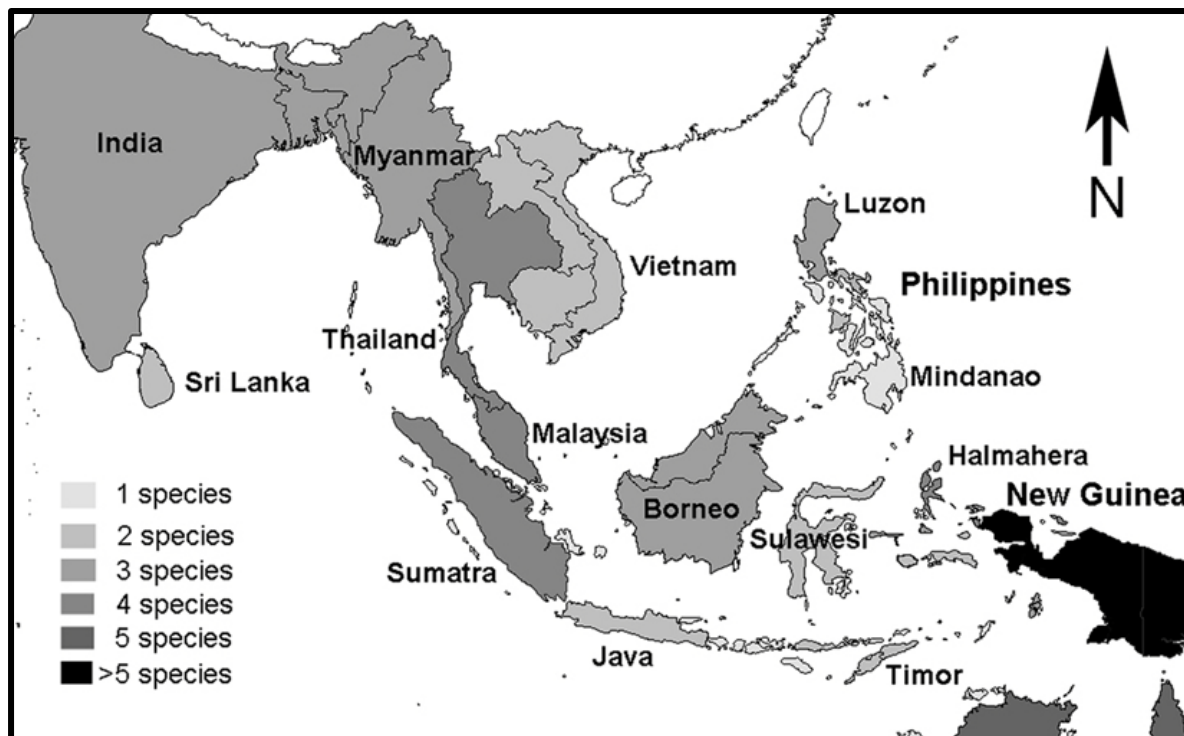
suggesting that the diversity of Australian varanids is probably well documented (but see Smith et al. 2004). Because taxonomy is a dynamic discipline, further changes and additions to the list of extant monitor lizards are to be expected. This will include new species descriptions (either new discoveries or through the splitting of already recognized species) as well as changes in the status of individual taxa.

### ***Significance of a critical review of Southeast Asian and Indo-Australian monitor lizards.***

—Due to their mainly large body size and their ecological role as top predators in most environments they inhabit (particularly east of the Sunda Shelf), monitor lizards have always been a small reptile group comparable to large placental carnivores (Sweet and Pianka 2007). Nevertheless, the diversity of monitor lizards has been largely underestimated for many decades. The need for a critical review of the regional species diversity with an updated taxonomy only 10 y after the last synopsis of extant varanids by Böhme (2003) derives from the publication of several new species descriptions since that time, most of which were discovered on Indo-Australian islands (Koch et al. 2010a). Moreover, monitor lizards are exposed to a variety of potential threats that have not been reviewed critically in previous reviews. Monitor lizards, and particularly such attractive species as the recently described *V. macraei*, *V. reisingeri*, and *V. boehmei*, are in great demand by the international pet trade (Iskandar and Erdelen 2006, Pernetta 2009). Others are severely impacted by the global reptile leather industry (Luxmoore and Groombridge 1990, Erdelen 1991, Shine et al. 1996, 1998, Traeholt 1998, Koch 2010), for human consumption and in traditional folk medicine (Baird 1993; Klemens and Thorbjarnarson 1995; Nguyen et al. 2003; da Nóbrega Alves et al. 2008), and by habitat destruction (Sodhi et al. 2010). In addition, knowledge about the distribution ranges of several rarely encountered monitor lizard species was only recently refined through examination of new voucher specimens and field surveys (e.g., Weijola 2010; Somma and Koch 2012).

Synopses of taxonomy, updated identification keys, and distribution data are essential requirements for monitoring and controlling international trade activities and quotas in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) relevant species. Therefore, our review of distribution, threats, and conservation status of Southeast Asian and Indo-Australian monitor lizards will be useful to customs officers and other governmental authorities to: (1) more strictly enforce the regulations of CITES; (2) monitor trade activities, annual harvest, and export quotas established in the source countries; (3) reduce current unsustainable





**FIGURE 1.** Map of South and Southeast Asia and the Indo-Australian Archipelago (excluding the Pacific island groups) showing the distribution of monitor lizard (*Varanus* spp.) diversity at species level. See Appendix I for details about the monitor lizard species inhabiting each country or main island.

harvest levels; and (4) prevent over-exploitation and extinction risks of *Varanus* spp. in the wild.

#### MATERIAL AND METHODS

**Study area.**—The geographic scope of the present review of Southeast Asian and Indo-Australian monitor lizards is based on the checklist by Robert Mertens (1959). Because the title of the checklist is vague, we define Southeast Asia to include mainland South and Southeast Asia from India through Bangladesh, Myanmar (Burma), Thailand, Cambodia, Vietnam, and Laos to southern China as well as the Malaysian peninsula. To cover all recognized members of the genus *Varanus* from mainland Southeast Asia and the Indo-Australian Archipelago (Fig. 1), we extended the study area to several Pacific island groups (the Solomon Islands, the Bismarck Islands, the Marshal Islands, and the Marianas). Thus, our study comprises not only the countless islands of the Philippines and Indonesia but also New Guinea and the many oceanic islands of Melanesia (including those of the Solomons, the Louisiades, and the Bismarcks) and Micronesia (including the Mariana, Marshal and Palau island groups). For reason of completeness, we also included the Australian *V. keithhornei* of the New Guinean *V. prasinus* species group. However, *V. griseus*, which was included in

Mertens' (1959) checklist, belongs to the distinct subgenus *Psammosaurus* and is excluded here because this monitor lizard species represents a saharosindic (i.e., Northern African to Central Asian) faunal element that only occurs in the very western part of the Indian subcontinent.

**Structure of *Varanus* species accounts.**—The present review represents an update of Mertens' (1959) taxonomic checklist, and basically follows Mertens' scheme, which has also been used in the volume about Helodermatidae, Varanidae, and Lanthanotidae in the famous series "Das Tierreich: Liste der rezenten Amphibien und Reptilien" (Mertens 1963), and the latest checklist of extant monitor lizard species by Böhme (2003). Thus, all taxa of monitor lizards treated are arranged alphabetically. Within the only recognized genus *Varanus* Merrem, 1820, of the Varanidae, the arrangement of the subgenera is alphabetical with the exception of the nominotypic subgenus *Varanus*, which is listed first. Within subgenera, species are again listed alphabetically, if they do not belong to closely related species groups (or species complexes). Within such species groups, taxa are arranged alphabetically except for the species that gave the group its name. And finally, within polytypic species, the subspecies are again arranged alphabetically, also beginning with the nominotypic one.

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The synonymy list of each monitor lizard taxon is arranged chronologically and starts with the original citation and source for the respective name and its type locality (terra typica). Chresonyms, that is, earlier authors' names that were later used by subsequent authors (or the same author), are generally not included with the exception of names with a changed taxonomic status such as subspecies names that were elevated to species rank. In these cases, the taxon name and the author are separated by a hyphen ("–"). For each taxon, the type specimens are given where possible. Type specimens have been examined in the following museum collections: Amsterdam (ZMA), Berlin (ZMB), Bogor (MZB), Bonn (ZFMK), Frankfurt (SMF), Leiden (RMNH), London (BMNH), Paris (MNHN), and Vienna (NHM). Information about the remaining type specimens was adopted from the original descriptions or collection catalogues (e.g., Good et al. 1993; Böhme 2010). Collection acronyms follow the overview by Leviton et al. (1985). Type specimens are followed by distribution data of the respective taxon (for a summary see Appendix I). The next section called "Comments" treats various topics such as distribution, nomenclature, systematics, and taxonomy. The subsection "Conservation Status" includes data about conservation status, export quotas, and potential threats of Indo-Australian monitor lizards, which originate from the species database of CITES (2012. Available from <http://www.cites.org/eng/resources/species.html>). Data about trade activities in *Varanus* spp. was taken from the CITES Trade Database, which is managed by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC 2012. Available from <http://www.unep-wcmc-apps.org/citestrade>). Additional information about the international trade with monitor lizards is based on surveys Mark Auliya conducted at wildlife dealers based in Indonesia, Thailand, and West Malaysia between 1998 and 2011. In 2005 and 2006, André Koch carried out field research on Sulawesi and some adjacent islands. He was accompanied by Evy Arida from the Zoological Museum in Bogor (MZB), Indonesia. Tables 2 and 3 provide an overview of export quotas, national and international protection, and IUCN Red List statuses (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. Available from <http://www.iucnredlist.org>).

### SPECIES ACCOUNTS

#### **Family Varanidae HARDWICKE & GRAY, 1827**

1827 Varanidae HARDWICKE & GRAY, Zoological Journal, London, 3:225.

1827 Uaranidae GRAY, The Philosophical Magazine, London, 2:54.

1834 Monitores WIEGMANN, Systematis Saurorum Prodrum, e Specimine Herpetologiae Mexicanae primo seorsim Editus 1:7.

1838 Monitoridae GRAY, Annals of Natural History, London, 1:392.

#### **Genus *Varanus* MERREM, 1820**

1815 *Varanus* RAFINESQUE, Analyse de la Nature:75 (nomen nudum).

1818 *Monitor* LICHTENSTEIN (non *Monitor* Blainville, 1816/Teiidae), Das Zoologisches Museum der Universität zu Berlin, 2:66.

1820 *Varanus* MERREM, Tentamen Systematis Amphibiorum:58. – Type species (Gray 1827: 55): *Varanus varius* (Shaw, 1790).

#### **Subgenus *Varanus* MERREM, 1820**

1820 *Varanus* MERREM, Tentamen Systematis Amphibiorum:58. – Type species (Gray 1827:55): *Varanus varius* (Shaw, 1790).

1843 *Pantherosaurus* FITZINGER, Systema Reptilium, 1:19. – Type species (by original designation): *Varanus gouldii* (Gray, 1838)

1927 *Placovaranus* FÉJÉRVÁRY, Termesztudományi Közlöny, 59:284. – Type species (by original designation): *Varanus komodoensis* Ouwens, 1912.

**Distribution.**—Australia, southern part of New Guinea, and some Lesser Sunda Islands (Komodo, Rinca, Padar, and Flores).

**Comments.**—Mertens (1942: 15) claimed that the typical species of the genus *Varanus* was the Australian *V. varius* (Shaw, 1790), by definition of Gray (1827: 55). Indeed, it was Merrem (1820) himself who listed *varius* as the first species for his new genus. Moreover, Mertens (1942) stated that Gray's (1827) use of the name *Uaranus* was actually an unjustified emendation of Merrem's (1820) name *Varanus*. Nonetheless, Mertens (1942) eventually concluded that the nomen Varanidae introduced by Hardwicke and Gray (1827:226) was the right name for all monitor lizards. Only two species of the subgenus *Varanus*, viz. *V. komodoensis* and *V. panoptes*, inhabit Southeast Asia and the Indo-Australian Archipelago.

#### ***Varanus komodoensis* OUWENS, 1912 (Fig. 2)**

1912 *Varanus Komodoensis* OUWENS, Bulletin du Jardin Botanique de Buitenzorg, 6:3. – Type locality: Komodo Island, Lesser Sunda Islands, Indonesia.

**Type specimens.**—Syntypes MZB Rept. 946 and RMNH 35517 (See comments below).

**Distribution.**—Lesser Sunda Islands of Komodo, Rinca, Gili Dasami, Gili Motang, Padar, and some coastal areas of Flores.





**FIGURE 2.** *Varanus komodoensis* is the largest living lizard of the world and a CITES Appendix I species. This specimen is from Rinca Island, Lesser Sunda Islands. (Photographed by Pauli Hien).

**Comments.**—De Lisle (2009) listed only two syntypes, although Ouwens (1912) mentioned five specimens in the original description.

**Conservation status.**—Since 1996, the species has been classified as “vulnerable” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). An update of its Red List status is therefore urgently required. The current major anthropogenic threat affecting local populations of *V. komodoensis* is the degradation of natural habitats through slash-and-burn activities (Auffenberg 1981, Ciofi and de Boer 2004), which in turn results in the fragmentation and decline of populations. Possibly a more serious concern is the illegal hunting of the species’ favored prey species, Timor Deer (*Cervus timorensis*) and Water Buffalos (*Bubalus arnee*; Murphy et al. 2002). Additionally, there are indications of an illicit trade of wild specimens as a direct threat to the species for the international pet industry, although *V. komodoensis* is listed in CITES Appendix I. Trade out of Indonesia does exist particularly for scientific purposes and zoos. Although some of these exported specimens have been taken from the wild on order from zoos, the majority is listed as captive-bred (Table 2). However, it is not clear whether all specimens listed as captive bred are truly captive bred under the CITES definition. According to the definition of “captive-bred” as applied by CITES, only F2 stock is considered as captive-bred (CITES 2012. Resolution Conf. 10.16. Specimens of animal species bred in captivity. Available from <http://www.cites.org/eng/res/all/10/E10-16R11.pdf>).

***Varanus panoptes horni* BÖHME, 1988**

1988 *Varanus panoptes horni* BÖHME, Salamandra, 24(2/3):90. – Type locality: Merauke, West Papua, New Guinea, Indonesia.

1991 *Varanus gouldii horni* - BÖHME, Mertensiella, 2:40.

**Type specimens.**—Holotype ZFMK 19290, paratypes ZFMK 14778-14781, ZSM 1/1970, ZMA 21701 (formerly ZFMK 14782).

**Distribution.**—Southern parts of New Guinea perhaps including islands of the Torres Strait.

**Comments.**—There has been some confusion in the past about the correct naming of this monitor lizard species and its morphologically similar (cryptic) sister species *V. gouldii* (Gray, 1838). For details we refer to Böhme (1991a), Shea and Cogger (1998), and the final ruling by the International Commission of Zoological Nomenclature (2000).

**Conservation status.**—The species is not listed in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). Between 2000 and 2010, Indonesia’s export volumes documented 1,692 farmed and captive-bred individuals (Table 2). However, a survey at registered Indonesian reptile breeding farms in 2006 could not confirm that *V. panoptes horni* was successfully bred under captive conditions (Auliya 2009). The species is also traded as *Varanus gouldii*. Currently, there is no

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**TABLE 2.** International and national protection, IUCN Red List statuses, and CITES trade data on 28 *Varanus* taxa native to Indonesia. Abbreviations are W: Wild-caught; F: Farmed; C: Captive-bred; R: Ratched; U: Source unknown; and I: Confiscated.

Species	CITES	IUCN	Protection Status	Export Quota (2012)	Trade of wild specimens suspended into the EU <sup>6</sup>	Export volumes reported by Indonesia (2000-2010)
<i>V. auffenbergi</i>	II	-	No	No	-	No CITES records
<i>V. beccarii</i>	II	-	No	No	x	34 <sup>4</sup> (W: 17; F: 17); 2,657 <sup>5</sup> (W: 1,106; F: 1,226; C: 325)
<i>V. boehmei</i>	II	DD	No	No	-	181 (all F)
<i>V. caerulivirens</i>	II	-	No	No	-	No CITES records
<i>V. cerambonensis</i>	II	-	No	No	-	No CITES records
<i>V. doreanus</i>	II	-	No	Yes	-	5,403 (W: 4,925; F: 474; U: 4)
<i>V. dumerilii</i>	II	-	No	Yes	x	6,757 (W: 5,595; F: 1,144; C: 14; U: 4)
<i>V. komodoensis</i>	I	VU	Yes	No	-	18 (W: 6; C: 12)
<i>V. kordensis</i>	II	-	No	No	-	140 (all C)
<i>V. indicus</i>	II	LC	Yes	No	-	1,763 (W: 54; C: 1,709)
<i>V. jobiensis</i>	II	LC	No	Yes	x	4,157 (W: 3,424; F: 646; C: 87)
<i>V. lirungensis</i>	II	-	No	No	-	No CITES records
<i>V. macraei</i>	II	-	No	No	-	1,676 (F: 1,670; C: 6)
<i>V. melinus</i>	II	-	No	No	-	2,531 (W: 5 <sup>3</sup> ; F: 2,526)
<i>V. nebulosus</i>	I	LC	Yes	No	-	-
<i>V. obor</i>	II	-	No	No	-	No CITES records
<i>V. panoptes horni</i> <sup>1</sup>	II	-	Yes	No	-	1,692 (F: 1,658; C: 34)
<i>V. prasinus</i>	II	-	Yes	No	-	2,413 (W: 2; C: 2,405; I: 6)
<i>V. rainerguentheri</i>	II	-	No	No	-	No CITES records
<i>V. reisingeri</i>	II	-	No	No	-	24 (all F)
<i>V. rudicollis</i>	II	-	No	Yes	-	11,219 (W: 8,258; F: 2,945; C: 12)
<i>V. salvadorii</i>	II	-	No	Yes	x	2,571 (W: 2,141; F: 430)
<i>V. salvator</i> ssp.	II	LC	No	Yes	-	6,214,310 skins (W: 6,201,615; F: 500; C: 303; U: 316; I: 11576); 58,489 live spec. (W: 54,549; F: 3,656; C: 284)
<i>V. similis</i>	II	-	No	No	-	253 (all F)
<i>V. timorensis</i>	II	-	Yes	No	-	8,072 (W: 31; R: 5; C: 8,036)
<i>V. togianus</i> <sup>2</sup>	II	-	Yes	No	-	-
<i>V. yuwonoi</i>	II	-	No	No	-	171 (F: 95; C: 76)
<i>V. zugorum</i>	II	-	No	No	-	No CITES records

<sup>1</sup>listed as *V. gouldii*; <sup>2</sup>listed as *V. salvator togianus*; <sup>3</sup>in three wild specimens the origin claimed was Mali; <sup>4</sup>reported as *V. prasinus beccarii*; in contrast importing countries reported the import of 847 *V. beccarii*; <sup>5</sup>reported as *V. beccarii*; <sup>6</sup>EU Regulation, No 828/2011, 17 August 2011 (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:211:0011:0032:EN:PDF>).

data available related to other threats detrimentally impacting the species.

### Subgenus *Empagusia* GRAY, 1838

1838 *Empagusia* GRAY, The Annals and Magazine of Natural History, 1:393. – Type species (Smith 1935): *Varanus flavescens* (Hardwicke & Gray, 1827).

1843 *Psammoscopus* FITZINGER, Systema Reptilium, 1:20. – Type species (by original designation): *Varanus flavescens* (Hardwicke & Gray, 1827).

1942 *Indovaranus* MERTENS, Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft, 462:16, 466:240. – Type species (by original designation): *Varanus bengalensis* (Daudin, 1802).

1942 *Dendrovaranus* MERTENS, Abhandlungen der Senckenbergischen naturforschenden Gesellschaft, 462:16, 466:241. – Type species (by original designation): *Varanus rudicollis* (Gray, 1845).

1942 *Tectovaranus* MERTENS, Abhandlungen der Senckenbergischen naturforschenden Gesellschaft,

462:16, 466:242. – Type species (by original designation): *Varanus dumerilii* (Schlegel, 1844).

**Distribution.**—From southeastern Iran and Afghanistan through Pakistan, India, Bangladesh and Nepal to Myanmar, Thailand, Malaysia, and the Greater Sunda Islands, Indonesia.

**Comments.**—The subgenus *Empagusia* represents a paraphyletic clade when compared with the molecular phylogeny by Ast (2001). If *Empagusia*, along with other current subgenera of *Varanus*, might be treated as full genus in the future, some of the Mertensian subgenera could perhaps be reinstated again as such.

#### ***Varanus bengalensis* species group:**

**Comments.**—The taxa *bengalensis* and *nebulosus* belong to the *Varanus bengalensis* species group. Böhme and Ziegler (1997a) discussed the taxonomic status of *nebulosus* and *bengalensis* in view of sympatric overlap of their distribution ranges in northern Thailand and southern Myanmar and suggested (semi-)specific rank for both taxa. Subsequent authors (e.g., Pianka 2004a) did not always follow this suggestion and listed *V. bengalensis* as a polytypic species with two subspecies based on Auffenberg's (1994) report of a continuous clinal variation in scale counts. Further investigations are required to solve this taxonomic issue.

#### ***Varanus bengalensis* (DAUDIN, 1802) (Fig. 3)**

1802 *Tupinambis bengalensis*, DAUDIN, Histoire naturelle, générale et particulière des Reptiles, 3:67. – Type locality: “Surinam” (in error).

1802 *Tupinambis cepedianus* DAUDIN, Histoire naturelle, générale et particulière des Reptiles, 3:43. – Type locality: unknown.

1802 *Lacerta argus* DAUDIN (in part), Histoire naturelle, générale et particulière des Reptiles, 3:117. – Type locality: “Surinam”

1820 *Varanus punctatus* MERREM, Tentamen Systematis Amphibiorum:59. – Type locality: Bengal

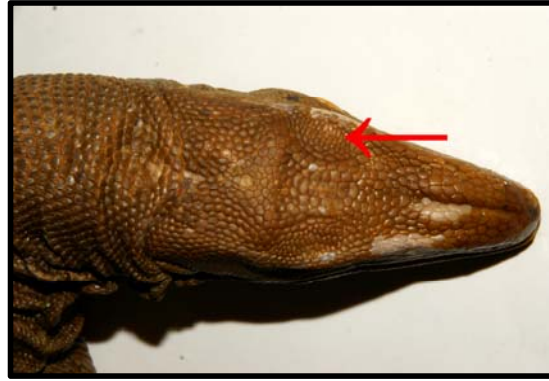
1820 *Varanus taraguira* MERREM (in part), Tentamen Systematis Amphibiorum:59. – Type locality: “In America meridionali”

1829 *Monitor gemmatus* GUERIN-MENEVILLE, Iconographie du Règne Animal, Rept. 1: pl. 3. - 1838 Rept. 3:7,24. – Type locality: “Indes Orientales”.

1831 *Monitor heraldicus* GRAY in GRIFFITH, The Animal Kingdom 9 Synops.:27. – Type locality: Bengal.

1842 *Varanus bibronii* BLYTH, Journal of the Asiatic Society of Bengal 11:869. – Type locality: unknown

1844 *Monitor inornatus* SCHLEGEL, Abbildungen Amphibien:72. – Type locality: “Neu Holland”



**FIGURE 3.** Dorsal view of the lectotype of *Varanus bengalensis* (MNHN 2179). Note the small (undifferentiated) supraocular scales above the eyes (red arrow), which are enlarged in its sister species *V. nebulosus*. (Photographed by André Koch).

1845 *Varanus lunatus* GRAY, Catalogue of lizards in the British Museum: 10. – Type locality: India

1987 *Varanus irrawadicus* YANG & LI, Herpetological Research [Chinese] 1:60. – Type locality: Wanding Valley, Yunnan Prov., southern China

**Type specimens.**—Lectotype MNHN 2179 (Fig. 3), by designation of Guibé (1954). From the original species description, Brygoo (1987) concluded that Daudin (1802) had at least three specimens at hand when describing his *Tupinambis bengalensis*. The whereabouts of the remaining type specimens is unknown (Brygoo 1987).

**Distribution.**—Southeastern Iran, Afghanistan, Pakistan, India, Nepal, Bangladesh, and Myanmar.

**Comments.**—See species group comments.

**Conservation status.**—The species (including *nebulosus* as a subspecies of *bengalensis*) is classified as “least concern” (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). *Varanus bengalensis* is listed in Appendix I of CITES. During the last 10 y, the CITES Trade Database records only two shipments; in 2000, 14 skins (likely *V. nebulosus*) from Indonesia as reported by Portugal as the importing country; and in 2010, one leather product from the US to Germany (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Today, the trade in skins appears of much less concern, compared to the early 1980s when thousands of skins were exported from Bangladesh and Pakistan to Japan (Luxmoore and Groombridge 1990). Hunting specimens can be considered as a potential local threat. Apart from consumption purposes (flesh is eaten by some local tribes), *V. bengalensis* is used for making





FIGURE 4. *Varanus nebulosus* was long treated as a subspecies of *V. bengalensis* but is now considered a distinct species. A juvenile from Tioman Island, Malaysia. (Photographed by Pauli Hien).



FIGURE 5. An adult *Varanus nebulosus* from Tioman Island, Malaysia. (Photographed by Mark Auliya).

traditional medicines (International Union for Conservation of Nature, IUCN Red List of Threatened Species, Version 2011.2. Papenfuss, T., S. Shafiei Bafti, M. Sharifi, D. Bennett, and S.S. Sweet. 2010. *Varanus bengalensis*. Available from <http://www.iucnredlist.org/apps/redlist/details/164579/0> [Accessed 23 November 2011]; Chakravorty et al. 2011). In Laos, the species is decreasing due to a continued harvest for local uses (Johnson et al. 2003).

***Varanus nebulosus* (GRAY, 1831)** (Figs. 4, 5)

1831 *Monitor nebulosus* GRAY in GRIFFITH, The Animal Kingdom, 9, Synopsis:27. – Type locality: Java, Indonesia.

1836 *Varanus nebulosus* - DUMERIL & BIBRON, *Erpétologie Général*, 3:483.

1942 *Varanus (Indovaranus) bengalensis nebulosus* - MERTENS, *Abhandlungen der Senckenbergischen naturforschenden Gesellschaft*, 465:184.

1994 *Varanus vietnamensis* YANG & LIU, *Zoological Research [Chinese]*, 15(1):11. – Type locality: “north Vietnam” (the holotype was bought from a Vietnamese dealer on a Chinese market in Hekou, Yunnan).

2003 *Varanus (Empagusia) nebulosus* - BÖHME, *Zoologische Verhandlungen*, 341:15.

**Type specimen.**—Holotype MNHN 8258.

**Distribution.**—Southern Myanmar, Thailand, Southern Vietnam, Malaysian Peninsula, Sumatra, and Java.

**Comments.**—See species group comments.

**Conservation status.**—Classified as a subspecies of *V. bengalensis*, the species is listed as “least concern” (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version

2011.2. 2011. *op. cit.*). *V. nebulosus* is listed in Appendix I of CITES. No trade information specifically of *V. nebulosus* is compiled in the CITES Trade Database (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Instead, it is covered under *V. bengalensis*, revealing that Thailand exported more than 50,000 skins in the mid-1980s. Today, *V. nebulosus* may thrive in regions where local beliefs protect the species (Stanner 2011). In other regions, it is less common but not necessarily rare (Lauprasert and Thirakhupt 2001). Across the species range, *V. nebulosus* is hunted for its flesh and specific medicinal properties (Auffenberg 1994), which in turn also stimulates illegal trade activities. Seizures are more or less regularly reported from peninsular Malaysia (see compilations of ASEAN-WEN, the Association of Southeast Asian Nations’ Wildlife Enforcement Network. Available from <http://www.asean-wen.org>).

***Varanus dumerilii* (SCHLEGEL, 1844)** (Figs. 6, 7)

1844 *Monitor Dumerilii* SCHLEGEL, *Abbildungen Amphibien*:78. – Type locality: “Borneo”, restricted to Banjarmasin, southeastern Borneo, Indonesia, by Mertens (1942).

1881 *Varanus macrolepis* BLANFORD, *Journal of the asiatic Society of Bengal*, 50(2):239. – Type locality: Tenasserim, most likely environs of Tavoy.

1892 *Varanus heterophilis* BOULENGER, *Proceedings of the zoological Society of London*, 1892: 506. – Type locality: Mt. Dulit, upper Baram River, Sarawak, Malaysia.

**Type specimen.**—Holotype RMNH 3168.

**Distribution.**—Southern Myanmar, Thailand, Malaysian Peninsula, Borneo, Sumatra, Natu, Bangka, and Billiton.

**Comments.**—In the literature, the year of

**TABLE 3.** Indonesian export quotas (2005–2011) for seven live *Varanus* spp. as communicated by CITES (www.cites.org, [Accessed 15 November 2011]). *Varanus indicus*, *V. komodoensis*, *V. nebulosus*, *V. panoptes horni* (listed as “*V. gouldii*”), *V. prasinus*, *V. timorensis*, and *V. togianus* (listed as *V. salvator togianus*) are nationally protected monitor lizard species and not subject to an annual quota system (see Table 2). For *V. salvator* live specimens (\*) and skins and skin products (\*\*\*) are separately listed.

Species	2005	2006	2007	2008	2009	2010	2011
<i>Varanus beccarii</i>	0	0	0	0	0	0	0
<i>Varanus doreanus</i>	500	500	500	540	540	540	540
<i>Varanus dumerilii</i>	400	400	400	900	900	900	900
<i>Varanus jobiensis</i>	300	300	300	450	450	450	450
<i>Varanus rudicollis</i>	900	900	900	900	900	900	900
<i>Varanus salvadorii</i>	200	200	200	270	270	270	270
<i>Varanus salvator</i> *	5,400	9,000	9,000	5,400	5,400	5,400	5,400
<i>Varanus salvator</i> **	444,600	441,000	441,000	426,600	426,600	413,100	426,600



**FIGURE 6.** Juveniles of *Varanus dumerilii* are very colorful. This specimen is from Lake Pedu near Kedah, Malaysia. (Photographed by Ulrich Manthey).



**FIGURE 7.** The attractive coloration of juvenile *Varanus dumerilii* fades in adult specimens. Note the enlarged dorsal scales in this species. (Photographed by Thomas Ziegler).

publication of the name *Monitor Dumerilii*, Schlegel, has often been given as 1839 (see e.g., Smith 1935; Mertens 1942; Böhme 2003). Stejneger (1907), however, who discussed the publication dates of the three parts of Schlegel’s (1837–44) “Abbildungen neuer oder unvollständig bekannter Amphibien (...)” [= Pictures of new or incompletely known amphibians] stated that pages 65 to 141 were published early in 1844. De Rooij (1915), for instance, also provided this year as date of publication. The subspecies *heteropholis* Boulenger, 1892, was considered invalid by Brandenburg (1983) and Sprackland (1993a).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus dumerilii* is listed in Appendix II of CITES. This monitor lizard species is particularly in demand as a pet due to its brightly colored juveniles (Fig. 6). Indonesia is the major exporter. Between 1991 and 2010, the country exported >11,000 wild specimens. Additionally, between 2000 and 2009, Indonesia documented the export of another 1,144 farmed specimens (see also Table 3). In comparison, Malaysia and Thailand each exported between 1,300 and 1,500 specimens between 1976 and 2001 (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). The species is not protected

under Indonesian law and in 2011 the annual export quota was 900 specimens (Table 3).

At this stage, it is not known what impact the international pet trade may have on local populations of *V. dumerilii*. There are no good data on population estimates available except that the species appears to be rare (possibly related to its secretive life habits; Bennett and Lim 1995). Current information suggests that clearing and ongoing fragmentation of forest habitats can be considered as a potential threat to this partly arboreal species, which is associated to diverse forest types (Bennett and Lim 1995; Cota et al. 2008).

***Varanus flavescens* (HARDWICKE & GRAY, 1827)** (Fig. 8)

1827 *Monitor flavescens* HARDWICKE & GRAY, Zoological Journal, 3:226. – Type locality: “India”, restricted to Calcutta, West Bengal, India by Auffenberg et al. (1989).

1830 *Varanus russelii* HEYDEN in RÜPPELL, Atlas Reise nördliche Afrika, Reptilien: 23. – Type locality: Bengal.

1836 *Varanus picquotii* DUMÉRIL & BIBRON, Erpétologie Générale, 3:485. – Type locality: Bengal 1844 *Monitor exanthematicus indicus* SCHLEGEL, Abbildungen Amphibien: x. – Type





FIGURE 8. *Varanus flavescens* from southern Asia is listed in CITES Appendix I. (Photographed by Rune Midtgaard).

locality: "Bengalen".

1856 *Varanus diardii* HALLOWELL, Proceedings of the Academy of Natural Sciences of Philadelphia, 8:150. Nomen nudum according to Mertens (1942).

**Type specimen(s).**—Not designated (see comments below).

**Distribution.**—From Pakistan through India to Bangladesh and Myanmar.

**Comments.**—Hardwicke and Gray (1827) stated that their description of *Monitor flavescens* was based on a drawing. According to De Lisle (2009), the "iconotype" of *V. flavescens* was depicted on plates 60 and 61 in Hardwicke's (1829) "Illustrations of Indian Zoology." This work, however, was published by Gray as a series between 1830 and 1835 (Wheeler

1998). For *M. flavescens*, Mertens (1942) referred to plate 67 in the second part (1834) of this work, which probably represents the "iconotype" of this taxon.

**Conservation status.**—Since 1996, the species has been classified as "least concern" in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). Updating of its Red List status is therefore urgently required. *Varanus flavescens* is listed in Appendix I of CITES. In the past, the species was highly sought after for the skin trade. Between 1975 and 1993, more than 640,000 skins were exported with Bangladesh (46%) and India (39%) as the major source countries (UNEP-WCMC. CITES Trade Database. 2012. *op. cit.*). Luxmoore and Groombridge (1990) described the species' susceptibility to over-exploitation, thus warranting



FIGURE 9. A juvenile of *Varanus rudicollis* at a reptile trader on Java. (Photographed by Mark Auliya).



FIGURE 10. An adult *Varanus rudicollis*. Characteristic for this monitor species are the enlarged nuchal scales. (Photographed by Wolfgang Grossmann).



**FIGURE 11.** A subadult specimen of *Varanus indicus* from Mount Bosavi, Papua New Guinea. Typical for this species are the dark tongue and the lack of blue pigmentation on the tail. (Photographed by Ulla Lohmann).



**FIGURE 12.** An adult specimen of *Varanus indicus* from Bensbach River, western Papua New Guinea. Note the brightly colored throat of this species and the finely speckled dorsal pattern. (Photographed by Mark O'Shea).

Appendix I status of CITES. Visser (2004) corroborated *V. flavescens* being one of world's most threatened monitor lizard species. A recent study from Nepal suggests that next to the impact through (illegal) hunting for skins and meat, potential threats to *V. flavescens* also include the degradation of natural habitats and the use of pesticides (Khatiwada and Ghimire 2009).

***Varanus rudicollis* (GRAY, 1845)** (Figs. 9, 10)

1845 *Uranus rudicollis* GRAY, Catalogue of the Lizards in the British Museum: 10. – Type locality: “Philippines” (in error).

1932 *Varanus scutigerulus* BARBOUR, Proceedings of the New England zoological Club, 13:1. – Type locality: Kampong Ulu, Malan River, Sarawak, Malaysia.

1962 *Varanus swarti* MANGILI, Giardino Zoologico Roma, 4:30. – Type locality: not given

**Type specimen.**—Holotype BMNH 1842.2.15.239.

**Distribution.**—Southern Thailand and Myanmar, Malaysian Peninsula, Bangka, Riau, Borneo, and Sumatra.

**Comments.**—Genetically, *V. rudicollis* is the closest living relative of the subgenus *Soterosaurus* (Ast 2001).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus rudicollis* is listed in Appendix II of CITES. In the period of 1975–2010, exporting countries documented more than 21,000 exports of live specimens (see also Table 3), of which Indonesia contributed approximately 80% (14,160 wild and almost 3,000 farmed specimens). Bennett and Lim (1995) conducted a mark-recapture study of the species in Peninsular Malaysia, and, despite no recapture, they believed that the species may be more abundant than assumed. However, as *V. rudicollis* shares similar life habits as *V. dumerilii*, it

may be assumed that clearing of primary and secondary forests contribute to local declines of this forest species (Bennett and Lim 1995; Lauprasert and Thirakhupt 2001). Likewise, whether the impact through the pet trade is detrimental to the species cannot be ascertained at this stage. The species is not protected under Indonesian law and in 2011 the annual export quota was 900 specimens (Table 3). However, observations at pet traders' facilities in West Kalimantan (Fig. 69) support the impression that several individuals fall victim to poor temporary housing and transport conditions prior to export (Auliya 2006).

**Subgenus *Euprepiosaurus* FITZINGER, 1843**

1843 *Euprepiosaurus* FITZINGER, Systema Reptilium, 1:19. – Type species: *Varanus indicus* (Daudin, 1802).

**Distribution.**—Moluccas, New Guinea, Northern Australia, and various Pacific island groups such as the Bismarck Archipelago, the Solomons, and the Marshall Islands.

**Comments.**—The subgenus *Euprepiosaurus* comprises two monophyletic clades, viz. the species groups of Pacific or Mangrove Monitors around *V. indicus* and the Tree Monitors around *V. prasinus*.

***Varanus indicus* species group:**

**Comments.**—Currently, the *Varanus indicus* species group comprises 13 members, most of which were described within the last 15 years, but further taxa are expected to be described in the future (Koch et al. pers. obs.). *Varanus spinulosus* (Fig. 65) was originally described as a subspecies of *V. indicus* (Mertens 1941) and long listed in the *V. indicus* species group, but was recently demonstrated to be only distantly related (Böhme and Ziegler 2007). Therefore, this species was excluded from the subgenus *Euprepiosaurus* (see below).





**FIGURE 13.** *Varanus caerulivirens* is characterized by a light, flesh-colored tongue and a bluish tinge on the body and tail. Although no trade in *V. caerulivirens* is documented by CITES (Table 3), specimens like this are regularly exported under the name of *V. indicus*. (Photographed by Thomas Ziegler).



**FIGURE 14.** A very colorful adult specimen of *Varanus caerulivirens*. The amount of blue coloration varies among specimens. (Photographed by Kai Philipp).

***Varanus indicus* (DAUDIN, 1802)** (Figs. 11, 12)

1802 *Tupinambis indicus* DAUDIN, Histoire naturelle, générale et particulière des Reptiles, 3:46. – Type locality: Ambon, Moluccas, Indonesia.

1820 *Varanus guttatus* MERREM, Tentamen Systematis Amphibiorum:58. – Type locality: “Bengal”, to be corrected into “Amboine” according to Mertens (1963).

1830 *Monitor kalabeck* LESSON in DUPEREY, Voyage Coquille, Zoologie 2(1):52. – Type locality: Offack (= Fofak) Bay, northern coast of Waigeu Island, Irian Jaya, Indonesia (Nomen dubium according to Böhme et al. 1994).

1830 *Monitor douarrha* LESSON in DUPEREY, Voyage Coquille, Zoologie 2(1):53. – Type locality: Praslin harbor, New Mecklenburg, Bismarck Archipelago (nomen dubium according to Böhme et al. 1994).

1831 *Monitor chlorostigma* GRAY in GRIFFITH, The Animal Kingdom, 9, Synopsis: 26. – Type locality: Rawack Island, north of Waigeu Island, Irian Jaya, Indonesia.

1926 *Varanus indicus rouxi* MERTENS, Senckenbergiana, 8:276. – Type locality: Durdjela, Wammer, Aru Islands.

1929 *Varanus tsukamotoi* KISHIDA, Lansania, 1:13. – Type locality: Saipan, Caroline Islands.

1988 *Varanus (Euprepiosaurus) indicus* - BÖHME, Bonner zoologische Monographien, 27:139.

**Type specimen.**—Neotype ZFMK 70650, designated by Philipp et al. (1999).

**Distribution.**—Moluccas (Ambon, Halmahera, Ternate, Buru, Haruku, and Seram), New Guinea (and offshore islands Salawati, Waigeo, Biak, and Japen), Bismarck Archipelago (New Britain, New Ireland, and Duke of York), Solomon Islands, Torres Strait Islands and Northern Queensland, Australia, and Mariana and Caroline Islands.

**Comments.**—*Varanus indicus* has the second largest distribution range of all varanids. In the past, some cryptic species, which co-exist with *V. indicus* in sympatry on New Guinea and Northern Australia (Ziegler et al. 2001, 2007a), have been described or revalidated from synonymy (e.g., Böhme et al. 1994).

**Conservation status.**—Since 2010 the species has been classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). *Varanus indicus* is listed in Appendix II of CITES. According to Luxmoore et al. (1988), thousands of skins were traded in the early 1980s. In 1990, almost 2,000 specimens of *V. indicus* were exported from the Solomon Islands (Leary 1991). In the period from 1997 to 2009, Indonesia claimed the export of > 1,700 specimens as captive-bred (Table 3), while importing countries claimed > 700 specimens between 1997 and 2010 as captive-bred from Indonesia. The species is protected in Indonesia, implying that only captive-bred specimens can leave the country (see also comments under *V. komodoensis*). However, a survey at registered Indonesian reptile breeding farms conducted in 2006 could not confirm successful captive breeding operations of this species (Auliya 2009). Between 1991 and 2002, Indonesia claimed approximately 2,750 exports of wild *V. indicus* specimens but importing countries claimed additionally > 800 wild specimens from Indonesia. Other countries exporting captive-bred and wild specimens, skins, pieces of skins, and leather products of *V. indicus* are the Solomon Islands and Papua New Guinea (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Aside the impact of the international trade, the species is regionally hunted for food and the degradation of natural habitats must also be considered as a threat to



**FIGURE 15.** *Varanus cerambonensis* was described as a sibling species of *V. indicus* (Figs. 11, 12) from the Moluccas. (Photographed by Kai Philipp).



**FIGURE 16.** Head portray of *Varanus cerambonensis*. Clearly visible is the light temporal stripe behind the eye which is not present in *V. indicus* (Figs. 11, 12). (Photographed by Kai Philipp).

*V. indicus* (International Union for Conservation of Nature, Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus indicus*. 2010. Available from <http://www.iucnredlist.org/apps/redlist/details/178416/0> [Accessed 27 November 2011]). In many parts of its extensive distribution range it appears to be common, gaining the impression that overall threats do not detrimentally impact populations of *V. indicus*. However, Leary (1991) indicated that 117 specimens were collected from Savo Island (ca. 30 km<sup>2</sup>), Solomon Archipelago, within the first half of 1989 and could not rule out the removal of additional undetected specimens from that little island.

This case demonstrates the importance of efficiently regulating the trade of island species and populations to prevent localized extinctions. Over much of the species' range, however, nothing is known about the conservation status of regional and local populations of *V. indicus*.

***Varanus caerulivirens* ZIEGLER, BÖHME & PHILIPP, 1999** (Figs. 13, 14)

1999 *Varanus caerulivirens* ZIEGLER, BÖHME & PHILIPP, *Herpetozoa*, 12(1\2):46. – Type locality: Halmahera, Moluccas, Indonesia.

**Type specimens.**—Holotype ZFMK 68874, paratypes ZFMK 68577, SMF 32805.

**Distribution.**—Northern Moluccan islands of Halmahera, Bacan, Morotai, and Obi.

**Comments.**—Since its description by Ziegler et al. (1999a), *V. caerulivirens* was considered endemic to the type locality. New island records were recently provided by Weijola (2010).

**Conservation status.**—*Varanus caerulivirens* has not been assessed in the IUCN Red List. The species is listed in Appendix II of CITES. Although *V. caerulivirens* does occur in the international pet trade (Ziegler et al. 1998), this is not documented by CITES (Table 3). It is very likely that this species, due to its phenetic similarity to other Pacific monitor lizards, is unofficially exported under the guise of look-a-like congeners (i.e., *V. indicus*). There is no information to determine whether the pet trade has a detrimental impact on populations of the species. However, pet traders are well established in the Moluccas and are also responsible for collecting congeners in substantial numbers (see comments under *V. melinus*). General threats that monitor lizards of this region are exposed to are the destruction and alteration of natural forested habitats (see Weijola and Sweet 2010). Whether there are other potential threats resulting in the decline of *V. caerulivirens* is not known.

***Varanus cerambonensis* PHILIPP, BÖHME & ZIEGLER, 1999** (Figs. 15, 16)

1999 *Varanus cerambonensis* PHILIPP, BÖHME & ZIEGLER, *Spixiana*, 22(3):281. – Type locality: Laimu, south coast of Ceram, Moluccas, Indonesia.

**Type specimens.**—Holotype ZFMK 70617, paratypes ZFMK 70618-619, 70651, RMNH 3150, 3152, 3189, 7196, 7297a-h, ZMA 11146a, ZMB 4848.

**Distribution.**—Central Moluccas (Ceram, Ambon, Buru, and Banda Islands).

**Comments.**—*Varanus cerambonensis* is a cryptic species and only recent studies demonstrated that it is





FIGURE 17. *Varanus doreanus* possesses a blue tail. This specimen is from Waigeo Island. (Photographed by Amir Hamidy).



FIGURE 18. Head portray of *Varanus doreanus*. Characteristic is the dark marbled throat as compared to other members of the *V. indicus* species complex. Note also the round nostril in this species. (Photographed by Amir Hamidy).



FIGURE 19. The juvenile holotype of *Varanus finschi* (ZFMK 26347) shows the typical ocellated color pattern of this species. Although not documented by CITES, this species is occasionally traded under different names. (Photographed by André Koch).

specifically distinct from the sympatric *V. indicus* (Philipp et al. 1999). The only record of this species from Obi (RMNH 3184) turned out to be *V. rainierguentheri* (Weijola 2010).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus cerambonensis* is listed in Appendix II of CITES. Although this species does occur in the international pet trade (Sprackland 2009), this is not documented by CITES (Table 3). Like *V. caerulevirens*, this species most likely has entered the international pet trade incorrectly declared as *V. indicus* (Figs. 11, 12). Various threats, such as logging, expansion of agricultural and mining activities, and pollution have been described for the Central Moluccas (Monk et al. 1997). However, at present it cannot be considered with certainty how these threats along with the domestic use and pet trade affect the long-term survival of this species.

***Varanus doreanus* (A. B. MEYER, 1874)** (Figs. 17, 18, 68)

1874 *Monitor doreanus* A. B. MEYER, Monatsberichte der Königlich Preussischen Akademie der Wissenschaften, 1874:130. – Type locality: “Dore” (= Doreh), Berou Peninsula, Northwestern New Guinea, Indonesia.

1994 *Varanus doreanus* - BÖHME, HORN & ZIEGLER, Salamandra, 30(2):132.

1994 *Varanus doreanus doreanus* - BÖHME, HORN & ZIEGLER, Salamandra, 30(2):137.

**Type specimen.**—Neotype ZFMK 52922, by designation of Böhme et al. (1994).

**Distribution.**—New Guinea and its offshore islands Salawati, Biak, Waigeo, Aru Islands, and northern Queensland, Australia.

**Comments.**—The co-existence of *V. doreanus* and *V. finschi* on New Guinea, underlining the specific status of the latter taxon originally described as a subspecies of *V. doreanus*, was demonstrated by Ziegler et al. (1999b).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus doreanus* is listed in Appendix II of CITES. In the period from 1998 to 2010, almost 6,000 live specimens were exported from Indonesia, the only country officially exporting this species. The majority of specimens (ca. 91%) were sourced from the wild (Table 3). In addition, Indonesian management authorities documented almost 8% of the *V. doreanus* specimens





**FIGURE 20.** Characteristic for the Peach-throated Monitor Lizard *Varanus jobiensis* are the pinkish-orange throat, relatively large eyes, and the blue-banded tail. Otherwise present dark transverse bands on the back are not visible in this juvenile specimen of the dark color morph of *V. jobiensis* from Mount Victory, Oro Province, Papua New Guinea. (Photographed by Fred Kraus).



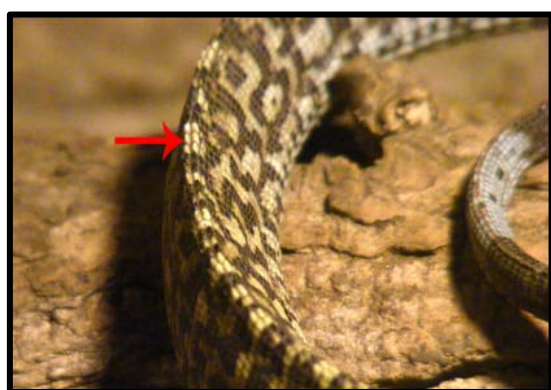
**FIGURE 21.** *Varanus jobiensis* shows some variation in coloration. This adult specimen of the bright color morph exhibits the typical dark transverse bandings on the dorsum. Clearly visible is the pinkish throat which can be blue in some specimens. (Photographed by Frank Jünemann).

as “farmed” (UNEP-WCMC. CITES Trade Database. 2012. *op. cit.*). The species is not protected in Indonesia, but it is allocated an annual export quota (Tables 2, 3). West Papua appears to be the major hunting region and most collectors are established in Sorong (WWF Regional Sahul 1999). The unsanitary conditions seen in 2011 for captured specimens held at collectors’ facilities in Sorong are not in favor of health conditions and may increase transport mortalities (Mark Auliya, pers. obs.). Along with other monitor lizard species, information on direct threats to this species other than the pet trade cannot be unequivocally ascertained at this stage. However, the degradation of pristine forest habitats and the expansion of oil palm plantations must be considered as a potential threat to *V. doreanus*.

***Varanus finschi* BÖHME, HORN & ZIEGLER, 1994**

(Fig. 19)

1994 *Varanus doreanus finschi* BÖHME, HORN &



**FIGURE 22.** The tail of *Varanus jobiensis* shows the dorsal double crest (red arrow) as typical for most members of the *V. indicus* species group. (Photographed by Frank Jünemann).

ZIEGLER, Salamandra, 30(2):137. – Type locality: Blanche Bay, New Britain Island, Bismarck Archipelago, Papua New Guinea.

1999 *Varanus finschi* - ZIEGLER, PHILIPP & BÖHME, Zoologische Abhandlungen, Dresden, 50(17):267.

**Type specimens.**—Holotype ZFMK 26347, paratypes ZFMK 26343-345, 26348, ZMB 14598, 26580a-c, 52998, 53000.

**Distribution.**—Bismarck Archipelago, north coast of New Guinea, Numpuur (= Numfur), Kai Islands, and Northern Queensland, Australia.

**Comments.**—The systematic status of the Kai Island population of *V. finschi* requires further investigations as these monitor lizards show differences in color pattern.

**Conservation status.**—Since 2010, the species has been classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). *Varanus finschi* is listed in Appendix II of CITES. Although populations of this species do occur in the international pet trade (Philipp et al. 2004; Sprackland 2009), this is not documented by CITES. Even though enforcement in Papua New Guinea (PNG) appears to be more strict than in Indonesia, illegal reptile trade activities in PNG (Smith 2011) as well as cross-border trade from PNG to Papua (Indonesia) of various wildlife is recognized (see Rhodin and Genorupa 2000; Hitchcock 2006; Lyons and Natusch 2011). Foufopoulus and Richards (2007) reported that the species apparently thrives in disturbed habitat. These authors also noted that logged pristine forests of New Britain are converted into various agricultural monocultures. Despite the fact



**FIGURE 23.** *Varanus juxtindicus* was occasionally kept and bred in captivity long before its real identity as a cryptic species of the *V. indicus* species group was solved. (Photographed by Rune Midtgaard).



**FIGURE 24.** The tail of *Varanus juxtindicus* (red arrow) is distinct from that of *V. indicus* in lacking a defined dorsal double crest (see Fig. 22). This morphological feature is unique among the different Pacific monitor lizard species. (Photographed by André Koch).

that *V. finschi* may overcome severe habitat degradation, the hunting for meat and skins may pose another additional direct threat to the species. Nonetheless, at present, focused studies documenting threats impacting on this monitor species and its populations are unavailable.

***Varanus jobiensis* AHL, 1932** (Figs. 20–22, 68)

1932 *Varanus indicus jobiensis* AHL, Mitteilungen aus dem Zoologischen Museum in Berlin, 17:892. – Type locality: Jobi (= Yapen) Island, West Papua, Indonesia.

1951 *Varanus karlschmidti* MERTENS, Fieldiana Zoology, 31:467. – Type locality: Marienberg, Sepik River, Papua New Guinea.

**Type specimen.**—Holotype ZMB 34106.

**Distribution.**—New Guinea and several off-shore islands such as Yapen, Biak, Salawati, Waigeo, and the Trobriand Islands (new record BMNH 95.10.17.7).

**Comments.**—The description of *V. jobiensis* by Ahl (1932) was overlooked by Mertens (1951), when he described *V. karlschmidti*. Böhme (1991b) pointed out the priority of the older name. *Varanus jobiensis* probably represents a composite species comprising several cryptic taxa (Horn 1977; Böhme and Ziegler 1997b). Therefore, Mertens' (1951) younger taxon *karlschmidti* could turn out to be revalidated in the future if it was shown to be taxonomically distinct. Further systematic investigations are needed.

**Conservation status.**—Since 2010, the species has been classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. 2011. *op. cit.*). *Varanus jobiensis* is listed in Appendix II of CITES. The species is not protected

under the Indonesian law. In 2011 the annual export quota for *V. jobiensis* was 450 specimens (Table 3). In the period from 1985 to 2010, Indonesia documented the export of 7,657 live specimens of which 5,706 (74%) were sourced from the wild. In addition, 114 specimens were claimed as captive-bred and 686 specimens as farmed (compare with remarks on *V. komodoensis*). Of the remainder (1,151 specimens) no source was indicated (Table 3).

As for *V. doreanus*, bad holding conditions for captive specimens of *V. jobiensis* at Papuan facilities were observed. Sorong is the main port of export to Java. Wild collected specimens are pooled in Sorong but are captured from various far-off locations (WWF Regional Sahul 1999). Although there is no data available how the pet trade affects *V. jobiensis*, the harvest of local populations must be considered with reservation (see *V. finschi*). Additional potential threats to this species such as the increase of forest degradation and clearings caused by agricultural development may be similar to other forest dwelling congeners.

***Varanus juxtindicus* BÖHME, PHILIPP & ZIEGLER, 2002** (Figs. 23, 24)

2002 *Varanus juxtindicus* BÖHME, PHILIPP & ZIEGLER, Salamandra, 38(1):17. – Type locality: Lake Tegano (= Te-Nggano), near Niupani, Rennell Island, Solomon Islands.

**Type specimens.**—Holotype ZMUC R E605, paratypes ZMUC R E617, ZMUC R 4223 – R 4224, and ZFMK 72865 (formerly ZMUC R 4225).

**Distribution.**—Known only from the type locality but a wider distribution in the Solomon Islands is certain (André Koch, unpubl. data).





**FIGURE 25.** The recently described *Varanus lurungensis* is an endemic of the Talaud Islands, North Sulawesi. This specimen of the original type series was captured with a noose by a local hunter on a coconut palm. (Photographed by André Koch).



**FIGURE 26.** *Varanus lurungensis* lacks a lateral light stripe behind the eyes and has a characteristic pinkish throat. (Photographed by Mark Auliya).

**Comments.**—Recently, Wesiak and Koch (2009) reported the successful keeping and breeding of *V. juxtindicus*. It seems that since the 1990s, this monitor lizard species was occasionally kept and bred in captivity unrecognized (see Wesiak 1993) long before its real identity as a cryptic species of the *V. indicus* species group was discovered by Böhme et al. (2002).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus juxtindicus* is listed in Appendix II of CITES. At this stage it cannot be ascertained whether exports of *V. indicus* from the Solomons also included specimens from Rennell Island, the type locality of *V. juxtindicus* (see conservation status of *V. indicus*, see also Leary 1991). However, no trade of *V. juxtindicus* is documented by CITES. Rennell Island is renowned among Pacific Islands for its high endemism. It appears that the East

Rennell Resource Management Plan in place backed by the Wildlife Protection and Management Plan can secure the island's unique biodiversity. Nonetheless, forest habitats can only remain intact if efforts are made continuously to educate locals in conservation management and related disciplines (Wingham 1987).

***Varanus lurungensis* KOCH, ARIDA, SCHMITZ, BÖHME & ZIEGLER, 2009** (Figs. 25, 26)

1915 *Varanus indicus* - DE ROOIJ (in part), Reptiles of the Indo-Australian Archipelago, 1:149.

1942 *Varanus (Varanus) indicus indicus* - MERTENS (in part), Abhandlungen der Senckbergischen naturforschenden Gesellschaft, 466:263.

2009 *Varanus lurungensis* KOCH, ARIDA, SCHMITZ, BÖHME & ZIEGLER, Australian Journal of Zoology, 57:33. – Type locality: near Lirung, Salibabu Island, Talaud Islands, Indonesia.



**FIGURE 27.** The exact distribution range of *Varanus melinus* in the Moluccas was unknown until recently. Nevertheless, this colorful monitor lizard species is exported in large numbers for the international pet trade. (Photographed by Thomas Ziegler).

**Type specimens.**—Holotype MZB Lac. 5178, paratypes MZB Lac. 5176-77, 5179-80, ZFMK 87587 (formerly ZMA15411a), ZMA 15411b.

**Distribution.**—Only known from the type locality.

**Comments.**—*Varanus lirungensis* inhabits the most northwesterly distribution of the *V. indicus* species group (Koch et al. 2009). At the same time, it has one of the smallest known distribution ranges of any monitor lizard species.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus lirungensis* is listed in Appendix II of CITES, but no trade since its description is documented (Table 3). It is very likely that the species prior to its description was traded as *V. indicus* (Figs. 11, 12), and this may have continued after its discovery. In 2009 and 2010, importing countries reported 129 captive-bred specimens, 11 wild and three confiscations of *V. indicus* (all originating from Indonesia) (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). As stated previously, *V. indicus* is protected under the Indonesian law, thus exports must be captive-bred (see comments for *V. indicus* above). The Talaud Islands attract foreign collectors, particularly those interested in the Red-and-Blue Lory (*Eos histrio*) and swallowtail butterflies (Papilionidae; Riley 1997). Extensive deforestation and agricultural development have occurred in the Talaud Islands. Additionally, gold and mineral explorations have been conducted on Karakelang Island (Riley 1997, 2002). In view of these threats, it appears likely that ongoing trade of *V. lirungensis* is detrimental to the species' survival.

***Varanus melinus* BÖHME & ZIEGLER, 1997** (Figs. 27, 28)



**FIGURE 28.** Juveniles of *Varanus melinus* are strikingly darker colored than adult specimens and can easily be confused with young *V. cumingi* from the Philippines (Fig. 50). (Photographed by Thomas Ziegler).

1997 *Varanus melinus* BÖHME & ZIEGLER, Herpetofauna 19(111):26. – Type locality: “Obi Island” (in error), Moluccas, Indonesia.

**Type specimens.**—Holotype ZFMK 65737, paratypes ZFMK 66357, 74278, 70441.

**Distribution.**—Mangole and Taliabu islands, Sula Islands, Moluccas, Indonesia.

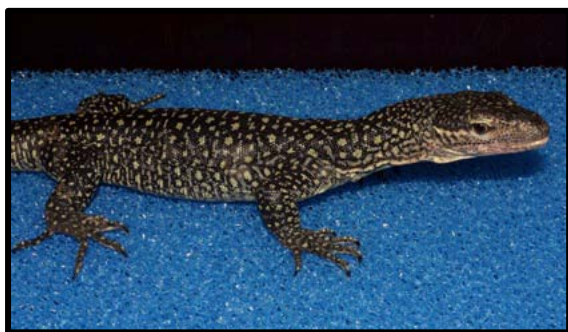
**Comments.**—The scientific description of *Varanus melinus* was based on captive animals, that allegedly originated from Obi Island. Instead, recent field work proved that this colorful monitor lizard species is restricted to the Sula Islands of Mangole and Taliabu (Weijola 2010). The existence of *V. melinus* on Banggai Island as indicated by Bayless and Adragna (1999) could not be confirmed (Koch et al. 2007).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus melinus* is listed in Appendix II of CITES. Between 2001 and 2010, Indonesia claimed the export of 2,527 farmed and five wild specimens of *V. melinus* (Table 3). *Varanus melinus* is not protected in Indonesia. Shipments of specimens referring to the source code F (i.e., farmed), indicate that “(...) animals born in captivity do not fulfil the definition of ‘bred in captivity’ of Resolution Conf. 10.16 (Rev.)” (CITES 2012, *op. cit.*). Wildlife farming is defined as a “modified wild harvest”, which implies that wild specimens are removed from a managed population (for more details see <http://www.cites.org/eng/com/ac/16/16-15.pdf>). These requirements are not strictly followed by the management authorities in the source country. In March 2006, registered reptile breeding facilities documented 102 wild stock and 144 F1-specimens of *V. melinus*, but a survey of all registered captive breeding premises could not confirm any





**FIGURE 29.** *Varanus obor* with unknown origin at a reptile trader on Ternate. The specimen is considerably brighter colored than those specimens from Sanana Island as depicted by Weijola and Sweet (2010) and demonstrates that the morphological variation in this melanistic species is higher than previously thought. (Photographed by Ruud de Lang).



**FIGURE 30.** The holotype of *Varanus rainerguentheri* shows a bright temporal stripe behind the eye and light-centered dark ocelli on the dorsum. (Photographed by Thomas Ziegler).



**FIGURE 31.** *Varanus* cf. *rainerguentheri* at a reptile trader in Japan. This sibling species from the Moluccas was recently described and is often traded as *V. indicus*. In this specimen, the light temporal stripe is only weakly developed. (Photographed by Mark Auliya).

successful breeding of this species (Auliya 2009). After the species' description in 1997, there was evidence enough to propose a transfer of *V. melinus* from CITES Appendix II to Appendix I (CITES, Conference of the Parties. Proposals for Amendment of Appendices I and II. 2000. Available from <http://www.cites.org/eng/cop/11/prop/43.pdf>) in view of the rarity and assumed localized distribution of the species. The rationale Germany (the proponent) provided was that this change would provide a safeguard against a likely predicted overharvest of the species in the wild. However, the CITES Secretariat has withdrawn the proposal because substantial data on population status and actual distribution was incomplete, and in turn recommended the Indonesian management authorities to establish a "conservative annual export quota for this species, in consultation with the Secretariat, to ensure that it is exploited sustainably" (CITES, Conference of the Parties. 2000. Available from [http://www.cites.org/eng/cop/11/doc/59\\_03.pdf](http://www.cites.org/eng/cop/11/doc/59_03.pdf)). Today, the actual distribution range of *V. melinus* has been localized and reflects its current global range. However, since the year 2000, when the eleventh meeting of the CITES-Conference of the Parties (COP 11) was held, no field survey on the species' population status has been conducted. In addition, no data is available on current annual harvest

levels and export quotas from Indonesia. A local reptile collector established on Mangole Island ascertained that wild populations of *V. melinus* have experienced a significant decline since 1997, when trade in this endemic and colorful monitor lizard species became commercial (K. Flores, pers. comm. in Weijola and Sweet 2010). According to this source more than 10,000 *V. melinus* have been removed from the Sula Islands standing in harsh contrast to the low number of officially exported wild-caught specimens (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*).

***Varanus obor* WEIJOLA & SWEET, 2010** (Fig. 29)  
2010 *Varanus obor* WEIJOLA & SWEET, Zootaxa, 2434:18. – Type locality: "Soela-Bési" (= Sanana Island), Sula Islands, Moluccas, Indonesia.

**Type specimen.**—Holotype RMNH 7225.

**Distribution.**—Endemic to the type locality Sanana Island.

**Comments.**—*Varanus obor* represents the latest discovery of the growing number of new members of the *V. indicus* species group.





**FIGURE 32.** *Varanus yuwonoi* from Halmahera is one of the most colorful and, thus, probably most threatened monitor lizard species. In addition, recent field observations revealed *V. yuwonoi* to be rare on Halmahera. (Photographed by Bernd Eidenmüller).



**FIGURE 33.** *Varanus zugorum* from Halmahera is one of the least known monitor lizard species of the world. This pet trade specimen was imported to Japan, one of the largest consumer markets for monitor lizards. (Photographed by Gou Suzuki).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus obor* is listed in Appendix II of CITES. Due to its recent description, the CITES Trade Database does not (yet) document any trade (Table 3), although specimens of *V. obor* are available in the international pet trade (Fig. 29). Therefore, the commercial trade impact on this monitor lizard species is unknown. However, similarly to *V. lirungensis* it is very likely that *V. obor* (as a member of the *V. indicus* group) has been traded as *V. indicus* (compare trade statistics above). The detrimental impact of trade is reported for *V. melinus* on the neighboring Mangole Island (Weijola and Sweet 2010). Other potential threats to the long-term survival of this endemic species include the destruction of forests on Sanana Island (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Iskandar, D., and Mumpuni. *Callulops kopsteini*. 2004. Available from <http://www.iucnredlist.org/apps/redlist/details/57738/0> [Accessed 06 December 2011]) and the introduction of exotic species such as the Malay Civet (*Viverra zibetha*) and the Cane Toad (*Bufo marinus*; Doody et al. 2009).

***Varanus rainerguentheri* ZIEGLER, BÖHME & SCHMITZ, 2007** (Figs. 30, 31)

2005 *Varanus* cf. *indicus* - BÖHME & ZIEGLER, *Salamandra*, 41:57.

2007 *Varanus rainerguentheri* ZIEGLER, BÖHME & SCHMITZ, *Mitteilungen des Museums für Naturkunde Berlin, Suppl.* 83:110. – Type locality: Jailolo, Halmahera Island, Moluccas, Indonesia.

**Type specimens.**—Holotype ZFMK 85404, paratype USNM 237438.

**Distribution.**—Northern Moluccan islands of Halmahera, Ternate, Tidore, Morotai, Bacan, Gebe and Obi.

**Comments.**—Until recently, *V. rainerguentheri* was only known from the type locality (Ziegler et al. 2007b). New field studies revealed that this species is more widespread in the northern Moluccas (Weijola 2010).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus rainerguentheri* is listed in Appendix II of CITES. The CITES Trade Database documents no trade of this species (Table 3). Like other members of the *V. indicus* group, however, it is evident that *V. rainerguentheri* is involved in the international pet trade due to its resemblance to closely-related Pacific monitor species (Fig. 31). Reptile collectors are well established throughout the northern Moluccas. One of the major traders is located on Ternate and has middlemen on Tidore, Halmahera, and the Sula Islands mainly collecting *Varanus* spp. and *Python* spp. destined for the international pet markets via the Jakarta hub (Ruud de Lang, pers. comm.). In addition, deforestation is a major threat, as documented through satellite imaging for the North Moluccas (Vetter 2009). Conservation issues in the management of protected area systems have been outlined for Halmahera (Setiadi et al. 2009).

***Varanus yuwonoi* HARVEY & BARKER, 1998** (Fig. 32)

1998 *Varanus yuwonoi* HARVEY & BARKER, *Herpetologica*, 54:36. – Type locality: Vicinity of Jailolo, Halmahera Island, Moluccas, Indonesia.

**Type specimens.**—Holotype UTA R-41281, paratype UCM 58747.

**Distribution.**—Only known with certainty from the type locality.

**Comments.**—Eyewitness accounts suggest this rare monitor lizard species to be more widespread in the northern Moluccas (Weijola 2010).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus yuwonoi* is listed in Appendix II of CITES. In the period 2005 to 2010, Indonesia exported 76 captive-bred and 95 farmed specimens (Table 3). However, a survey at reptile breeding facilities could not confirm any successful captive-breeding of *V. yuwonoi*. In March 2006, stock held in these premises was documented in 53 wild and 10 F1 specimens (Auliya 2009).

The species' remarkable color pattern may trigger international demand and thus be followed by a more focused harvest of this rare species in the wild (Weijola 2010). At this stage, however, it cannot be ascertained whether the international pet trade is detrimental to the species. For other potential threats, *V. yuwonoi* may be exposed to (see *V. caerulivirens* and *V. rainerguentheri*).

***Varanus zugorum* BÖHME & ZIEGLER, 2005** (Fig. 33)

2005 *Varanus zugorum* BÖHME & ZIEGLER, Salamandra, 41(1/2):52. – Type locality: Kampung Pasir Putih, Jailolo district, Halmahera Island, Moluccas, Indonesia.

**Type specimen.**—Holotype USNM 237439.

**Distribution.**—Only known from the type locality.

**Comments.**—*Varanus zugorum* appears to be the rarest and least known monitor lizard species, known only from the holotype specimen. Recent field work on Halmahera Island failed to record this secretive species (Setiadi and Hamidy 2006; Weijola 2010). Only two putative photographs of live specimens of *V. zugorum* exist (see link in Böhme and Ziegler 2005; Suzuki 2006; Fig. 33).

**Conservation status.**—*Varanus zugorum* has not been assessed in the IUCN Red List. The species is listed in Appendix II of CITES. The CITES Trade Database does not document any trade of this species (Table 3), although at least two specimens reached Japan in the past (Gou Suzuki, pers. comm.). The scarcity of records aside, anecdotal information likely reflects a species displaying arboreal habits (Böhme and Ziegler 2005), thus making any observations in the field difficult. Therefore, based on the poor overall dataset on *V. zugorum*, the lack of information about distribution and natural history, it is not clear if this species is really rare or merely escapes detection. Certainly, increasing deforestation rates on Halmahera are likely to lead to a population decline of this arboreal species. Field studies on *V. zugorum* are, therefore, urgently required.

### ***Varanus prasinus* species group:**

**Comments.**—Mertens (1942) placed the arboreal *V. prasinus* into the subgenus *Odatria* together with the Australian dwarf monitor lizards based on their round tail shape. Later, morphological studies on the lungs (Becker 1991) and hemipenes (Ziegler and Böhme 1997) placed *V. prasinus* and its allies as the sister group to the Pacific monitor lizards into the subgenus *Euprepiosaurus* (see also Sprackland 1991). This allocation was confirmed by molecular studies (Ast 2001; Ziegler et al. 2007a). Currently, the *V. prasinus* species group comprises nine different species from New Guinea and its off-shore islands, and represents major species supplying the international trade with monitors lizards as pets (see Table 2, Figs. 34–40).

***Varanus prasinus* (SCHLEGEL, 1844)** (Fig. 34; also shown in biosketch picture of Mark Auliya)

1831 *Monitor viridis* GRAY in GRIFFITH, The Animal Kingdom 9 Synopsis: 26. – Type locality: not mentioned (nomen dubium according to Mertens 1959)

1844 *Monitor prasinus* SCHLEGEL, Abbildungen Amphibien:78. – Type locality: “West-Küste Neu-Guineas” (= west coast of New Guinea); specified by Müller and Schlegel (1845) to “Fort du Bus, Baai Oeroe-Langoeroe” (= Fort du Bus, Triton Bay), south coast of New Guinea, Indonesia.

**Type specimen.**—Holotype RMNH 4812.

**Distribution.**—New Guinea and the offshore islands of Salawati and those of the Torres Strait.

**Comments.**—De Lisle (2009) mentioned two syntypes (MCG [MSNG] 28723 and RMNH 4812) for *V. prasinus*. The former specimen, however, is a syntype of *V. beccarii* (Böhme and Koch 2010). For the correct date of publication of the name *Monitor prasinus* Schlegel, 1844 we refer to the discussion by Stejneger (1907). De Rooij (1915) also gave 1844 as the date of publication.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus prasinus* is listed in Appendix II of CITES. This arboreal monitor lizard species from New Guinea is presumably the most sought-after *Varanus* species in the international pet trade. Over a 34-y period (1977–2010) more than 4,000 specimens were documented by importing countries (see also Table 3). Among these, 3,457 specimens (86%) were exported from Indonesia.

Interestingly, in 1991, Taiwan (Province of China) received 2,000 leather items of *V. prasinus* from Indonesia. Between 1997 and 2010, Indonesia claimed the export of 2,481 captive-bred specimens (CITES. CITES Resolution Conf. 10.16. 2012, *op. cit.*). A survey of reptile breeding farms revealed that



**FIGURE 34.** As typical for all Tree Monitor Lizards, *Varanus prasinus* has a round in cross section and prehensile tail that is used as a fifth limb when climbing. Due to its emerald green coloration, these monitor lizards are a focal species of the pet trade. (Photographed by Thomas Ziegler).

only two premises documented F2 stock (complying with the CITES captive breeding definition). For the period December 2005 to June 2006, one wildlife trading company documented four hatchlings while the other claimed 35 captive-bred *V. prasinus* (Auliya 2009). This information clearly contradicts trade information provided through the CITES Trade Database (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Accordingly, Indonesia exported more than 360 captive-bred specimens of *V. prasinus* in 2005 and 2006. The species is nationally protected in Indonesia. Thus, only F2 stock specimens are destined for exports. However, protected animal species in Indonesia are not subject to an annual quota system (Auliya 2009) and the high international demand in this attractive monitor lizard species along with the

weakly enforced national and international regulations provides loopholes such as the laundering of wild-captured individuals as captive-bred. From recent investigations of several alleged captive breeding companies in Indonesia, Nijman and Shepherd (2009) concluded that all specimens of *V. prasinus* exported as captive-bred are in fact wild-caught. This criminal practice has also recently been demonstrated in the trade with *Morelia viridis* on New Guinea (Lyons and Natusch 2011). In contrast to the other Tree Monitor species with restricted distribution ranges, the long-term survival of *V. prasinus* may be safeguarded due to the extensive distribution range of this species and its arboreal and secretive life habits. However, as has been demonstrated for *Morelia viridis*, ongoing and substantial off-take in wild specimens can lead to a decline of local and insular populations. Therefore, field surveys of the population status of *V. prasinus* in various parts of New Guinea are very desirable.

***Varanus beccarii* (DORIA, 1874)** (Figs. 35)

1874 *Monitor Beccarii* DORIA, Annali del Museo Civico di Storia Naturale di Genova, 6:331. – Type locality: Wokam, Aru Islands, Indonesia.

1942 *Varanus (Odatria) prasinus beccarii* - MERTENS, Abhandlungen der Senckbergischen naturforschenden Gesellschaft, 466:296.

2003 *Varanus (Euprepiosaurus) prasinus beccarii* - BÖHME, Zoologische Verhandlungen, 341:25.

2007 *Varanus (Euprepiosaurus) beccarii* - ZIEGLER, SCHMITZ, KOCH & BÖHME, Zootaxa, 1472:15.

**Type specimens.**—Syntypes ZMB 7993 and MSNG 28723; see comments below.



**FIGURE 35.** *Varanus beccarii* is a melanistic Tree Monitor Lizard that lacks any bright color pattern. (Photographed by Thomas Hörenberg).





**FIGURE 36.** *Varanus boehmei* is endemic to Waigeo Island. In its color pattern, this species is similar to *V. keithornei* (see Fig. 37) from North Australia. (Photographed by Thomas Ziegler).

**Distribution.**—Restricted to the Aru Islands.

**Comments.**—In the past, the taxon *beccarii* was considered a subspecies of *V. prasinus* (see e.g., Mertens 1942; Ziegler and Böhme 1997). Recently, however, Ziegler et al. (2007a) demonstrated that *V. beccarii* is specifically distinct from the latter species. Originally, the type series included three specimens (Doria 1874). Today, only two of these syntypes are known (Böhme and Koch 2010), the whereabouts of the third original specimen is unknown (Good et al. 1993). Of the remaining syntypes Wells and Wellington (1985) designated specimen MSNG 28723 the lectotype of *V. beccarii* without any reason.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus beccarii* is listed in CITES Appendix II. Individuals of this species in the pet trade are documented as either *V. prasinus beccarii* or *V. beccarii*, with Indonesia claiming the export of > 5,780 (1987–2009) and > 1,570 (1991–2010) live specimens, respectively (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Based on the documentation by Indonesia and importing countries, the majority of specimens were sourced from the wild (> 4,150 specimens), while > 1,600 were claimed as farmed and > 400 specimens as captive-bred (Table 3). *Varanus beccarii* was allocated varying annual export quotas between 1,350 wild specimens in 1997 and only 200 wild specimens in 2004 (UNEP-WCMC 2009).

Since 2005, no annual export quota exists for *V. beccarii*. In 1997 the import of wild specimens of *V. beccarii* into the European Union was suspended (UNEP-WCMC 2009), and according to the EU Regulation No 828/2011 of 17 August 2011, the suspension has been extended. In March 2006, a survey of all registered Indonesian reptile breeding facilities revealed 28 wild and 19 F1 stock (Auliya

2009). In contrast, the CITES Trade Database indicates exports (claimed by Indonesia and importing countries) of 336 farmed *V. beccarii* specimens in 2006, plus 124 farmed and 378 captive-bred specimens in 2007 (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Specific threats pertaining to *V. beccarii* are not known. However, human developments accompanied by logging activities on various islands of the Aru Islands (Hamburger 2010) must be considered as a potential threat to this arboreal monitor lizard species.

***Varanus boehmei* JACOBS, 2003** (Fig. 36)

2003 *Varanus boehmei* JACOBS, *Salamandra*, 39(2):66.  
– Type locality: Waigeo Island, West Papua, Indonesia.

**Type specimens.**—Holotype ZFMK 77837, paratypes ZFMK 82826, ZFMK 84000, and ZMA 21702 (formerly ZFMK 79122). The original type series, however, included seven specimens (Jacobs 2003), which have all been transferred to the ZFMK collection after their demise (H. J. Jacobs, pers. comm. August 2010). Therefore, the remaining three paratype specimens have to be considered lost as they can no longer be identified among the numerous ZFMK voucher specimens. The specimens displayed in the ZFMK vivarium have no type status.

**Distribution.**—Only known from the type locality.

**Comments.**—None.

**Conservation status.**—Since 2010, *V. boehmei* has been classified as “data deficient” in the IUCN Red List (IUCN, IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus boehmei*. 2010b. Available from <http://www.iucnredlist.org/apps/redlist/details/178267/0> [Accessed 08



**FIGURE 37.** A juvenile *Varanus keithhornei*. The bright chevrons on the dorsum may fade with age. (Photographed by Bernd Eidenmüller).

December 2011]) and listed in Appendix II of CITES. From 2005 to 2010, Indonesia documented the export of 181 farmed and one captive-bred specimen (Table 3). As of March 2006, Indonesian reptile breeding facilities officially declared a stock of 10 wild specimens (Auliya 2009). According to IUCN (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. 2010b. *op. cit.*) approximately 90% of all specimens involved in the international pet trade are harvested from the wild. Due to the lack of field surveys, it is at present not possible to ascertain, if populations have been over-harvested. However, due to its restricted distribution range along with other human imposed threats, such as (selective) logging, wild fires, and mining operations (Mauro 2004; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. BirdLife International. *Paradisaea rubra*. 2008b. Available from <http://www.iucnredlist.org/apps/redlist/details/106005840/0> [Accessed 09 December 2011]), *V. boehmei* must be considered threatened. Appropriate precautionary measures need to be taken to prevent the continuous exploitation of *V. boehmei*.

***Varanus bogerti* MERTENS, 1950**

1950 *Varanus prasinus bogerti* MERTENS, American Museum Novitates, 1456:3. – Type locality: “Fergusson (Moratau) Island”, d’Entrecasteaux Archipelago, Papua New Guinea.  
1991 *Varanus bogerti* - SPRACKLAND, Memoirs of the Queensland Museum, 30(3):571.

**Type specimens.**—Holotype AMNH 41639, paratypes AMNH 41638, 41640.

**Distribution.**—Island groups of d’Entrecasteaux, Trobriand, and Louisiade southeast of New Guinea.

**Comments.**—Originally described as a melanistic subspecies of *V. prasinus* (Mertens 1950), Sprackland (1991) elevated the taxon *bogerti* to full species status. Recently, Eidenmüller and Philippen (2008) depicted the holotype specimen for the first time. Until today, only half a dozen voucher specimens of *V. bogerti* have been identified in museum collections (Mertens 1959). Pictures of live specimens, however, do not exist and nothing is known about the exact distribution and biology of *V. bogerti*.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus bogerti* is listed in CITES Appendix II. In the period between 1996 and 2005, importing countries claimed 68 live specimens from Indonesia and one from Papua New Guinea all sourced from the wild (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). The lack of relevant data complicates any conservation-oriented assessment of this little known monitor lizard species.

***Varanus keithhornei* (WELLS & WELLINGTON, 1985) (Fig. 37)**

1985 *Odatia keithhornei* WELLS & WELLINGTON, Australian Journal of Herpetology, Suppl. 1:21. – Type locality: Buthen Buthen, Nesbit River, Cape York Peninsula, Queensland, Australia.

1991 *Varanus teriae* SPRACKLAND, Memoirs of the Queensland Museum, 30(3):570. – Type locality:





FIGURE 38. Unlike its close relative, *Varanus prasinus* (Fig. 34), *V. kordensis* shows a dark reticulated dorsal color pattern. (Photographed by Frank Mohr).

Buthen Buthen, Nesbit River, Cape York Peninsula, Queensland, Australia.

**Type specimen.**—Holotype QM J31566.

**Distribution.**—Restricted to Cape York Peninsula, Northern Queensland, Australia.

**Comments.**—Irwin (2004) erroneously listed QM J35450 and J35451 as paratype specimens of *V. keithornei*. Wells and Wellington (1985), however, mentioned only the holotype specimen in the original description. This is confirmed by Covacevich and Couper (1994). Both specimens are, however, the paratypes of *V. teriae* Sprackland, 1991, which is a synonym of *V. keithornei*. The holotype is the same specimen for both taxa.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus keithornei* is listed in Appendix II of CITES. The CITES Trade Database does not document any trade of this species (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). The Queensland Government does not allocate this arboreal monitor species to any of its threat categories (The State of Queensland, Department of Environment and Resource Management. Queensland Government Homepage. 2011. Available from <http://www.derm.qld.gov.au> [Accessed 08 December 2011]), although *V. keithornei* is considered rare in the Cape York Peninsula, and according to Irwin (2004) occupies the most restricted range among all Australian varanid species in this part of Queensland. However, due to its

cryptic life habits it may escape detection. Vincent and Wilson (1999) reported the species being abundant in some areas.

***Varanus kordensis* (A. B. MEYER, 1874)** (Fig. 38)  
1874 *Monitor kordensis* A. B. MEYER, Monatsberichte der Königlich Preussischen Akademie der Wissenschaften, 1874:131. – Type locality: “Mysore (Kordo)” (= Biak) Island, Schouten Archipelago, West Papua, Indonesia.

**Type specimen.**—Originally, the holotype was deposited in MTKD, but destroyed during the bombing of Dresden during World War II (Obst 1977). The recent neotype selection by De Lisle (2009) is invalid (Böhme and Koch 2010).

**Distribution.**—With certainty only known from the type locality.

**Comments.**—Originally described as a distinct species, Mertens (1942) classified the taxon *kordensis* as a subspecies of *V. prasinus* (Fig. 34). Without providing voucher specimens as proof, Sprackland (1991) claimed specimens with the typical reticulated *V. kordensis* pattern to exist sympatrically with *V. prasinus* on New Guinea. Thus, he treated the taxon *kordensis* as a synonym of *V. prasinus*. Jacobs (2002), however, demonstrated the morphological distinctiveness of the taxon *kordensis* and re-elevated the original species status. Recent molecular investigations revealed *V. kordensis* to be a basal member of the *V. prasinus* species group (Ziegler et al. 2007a).



FIGURE 39. The attractive *Varanus macraei* is restricted to Batanta Island off the coast of New Guinea. It is probably highly threatened by the commercial pet trade. (Photographed by André Koch).



FIGURE 40. *Varanus reisingeri* from Misool Island is the latest description of a Tree Monitor Lizard species. Its color is brighter yellow than in *V. prasinus* (see Fig. 34). This specimen was found at a reptile trader on Java. (Photographed by André Koch).

**Conservation status.**—*Varanus kordensis* has not been assessed in the IUCN Red List and is listed in CITES Appendix II. Interestingly, the CITES Trade Database documents transactions of *V. kordensis* since 1990. From this period onward until 1997 more than 1,530 wild specimens were claimed as exports from Indonesia. The documentation of trade records commenced again in 2007 until 2010, with Indonesia reporting the export of 140 specimens, all captive-bred (Table 3). Thus, no trade was reported between 1998 and 2006 (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Trade records of this species can also be queried as *Varanus prasinus kordensis*, referring to the period 1987–1997 and documenting the export of another > 1,650 live specimens. Only one transaction indicated the source “wild,” in the remaining transactions, no source was listed (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). The CITES Trade Database does not include information on harvest locations. Hence, the number of *V. kordensis* specimens entering the trade as *V. prasinus* cannot be determined.

In view of the species’ restricted range, and the detrimental impact other reptile populations have received on Biak Island (see Lyons and Natusch 2011), it does appear very likely that the current population status of *V. kordensis* on Biak Island is under threat. Like *V. boehmei*, it is necessary to implement precautionary measures to prevent the over-exploitation of *V. kordensis*. Other potential threats the species is exposed to have been compiled by the IUCN Red List in particular in evaluating threats of bird and mammal species endemic to Biak Island, such as habitat loss (> 50% of Biak’s forests are cleared) and subsistence farming (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. BirdLife International. *Megapodius geelvinkianus*. 2008a. Available from [\[redlist/details/160030043/0\]\(http://www.iucnredlist.org/apps/redlist/details/160030043/0\) \[Accessed 09 December 2011\]; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Leary, T., L. Seri, T. Flannery, D. Wright, S. Hamilton, K. Helgen, R. Singadan, A. Allison, R. James, F. Bonaccorso, and K. Aplin. 2008. \*Uromys boeadii\*. Available from <http://www.iucnredlist.org/apps/redlist/details/136773/0> \[Accessed 09 December 2011\]\).](http://www.iucnredlist.org/apps/</a></p></div><div data-bbox=)

***Varanus macraei* BÖHME & JACOBS, 2001**(Figs. 39) 2001 *Varanus macraei* BÖHME & JACOBS, Herpetofauna, 23(133):7. – Type locality: Batanta Island, West Papua, Indonesia.

**Type specimens.**—Holotype ZFMK 74558, paratypes ZFMK 84212, ZFMK 84213, and SMF 90077 (formerly ZFMK 84214). The original type series, however, comprised six specimens (Böhme and Jacobs 2001). Therefore, the remaining two paratype specimens have to be considered lost as they can no longer be identified among the numerous ZFMK voucher specimens.

**Distribution.**—Only known from the type locality.

**Comments.**—None.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus macraei* is listed in Appendix II of CITES. In the period 2003–2010, Indonesia claimed 1,670 exports of farmed *V. macraei*, and six captive-bred specimens. Interestingly, no exports referred to wild-caught individuals (Table 3). In March 2006, all Indonesian registered reptile breeding premises documented 93 wild and 86 F1 stock. However, a survey could not confirm any successful farming and captive-breeding efforts of *V. macraei* with some facilities only

possessing wild stock (Auliya 2009). In addition, illegal logging in particular of Merbau (*Intsia* spp.) is reported from West Papua and Papua provinces of New Guinea including Batanta Island (Newman and Lawson 2005; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. BirdLife International. *Paradisaea rubra*. 2008b. *op. cit.*), thus increasing deforestation rates may severely impact populations of the arboreal *V. macraei*. Considering the restricted distribution range of *V. macraei* and its enormous attraction for the international pet trade, ongoing uncontrolled trade in this New Guinean monitor lizard species is very likely detrimentally, and thus increasing the risk of extinction in the wild. Field studies of the population and conservation status of *V. macraei* are highly recommended.

***Varanus reisingeri* EIDENMÜLLER & WICKER, 2005**  
(Fig. 40)

1942 *Varanus (Odatia) prasinus prasinus* - MERTENS (in part), *Abhandlungen der Senckbergischen naturforschenden Gesellschaft*, 466:292.

2005 *Varanus reisingeri* EIDENMÜLLER & WICKER, *Sauria*, 27(1):4. – Type locality: “Insel Misol” (= Misool Island) off the west coast of West Papua, New Guinea, Indonesia.

**Type specimens.**—Holotype SMF 83679, two paratypes were alive at the time of the species description and still survived when this paper was written. They will to be deposited in SMF after their demise (Bernd Eidenmüller, pers. comm.).

**Distribution.**—Only known from the type locality.

**Comments.**—The taxonomic validity of this species has yet to be proven. It possibly deserves subspecies status of *V. prasinus* because morphological features of both taxa largely overlap.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus reisingeri* is listed in Appendix II of CITES. Between 2009 and 2010 the CITES Trade Database documents the export of 24 farmed specimens from Indonesia (Table 3). In 2009 South Africa reports the import of four captive-bred specimens from Indonesia (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Misool Island was destined as a harvest location for reptiles long before the description of *V. reisingeri* (WWF Regional Sahul 1999), and the species was likely unnoticed and exported as *V. prasinus* (see comments above).

***Varanus telenesetes* SPRACKLAND, 1991**

1991 *Varanus telenesetes* SPRACKLAND, *Memoirs of the Queensland Museum*, 30(3):569. – Type locality: Roussell (= Rossel) Island (probably in error, see

below), Louisiade Islands, Milne Bay Province, Papua New Guinea.

**Type specimen.**—Holotype QM J1190.

**Distribution.**—Unknown. See comments below.

**Comments.**—The elusive *V. telenesetes* is known only from the original type specimen, whose locality data have recently been questioned because the species could not be recorded on Rossel Island (F. Kraus, pers. comm. in De Lisle 2009). Therefore, the type locality is probably an error but *V. telenesetes* might occur on other islands in the Louisiade Archipelago (De Lisle 2009). Recently, Eidenmüller and Philippen (2008: 62) depicted the holotype specimen of *V. telenesetes*. In contrast to the original description by Sprackland (1991), the holotype is not “similar to *V. prasinus*” in being green dorsally with indistinct dark chevrons, but instead it is unicolored dark grey and, thus, largely resembles the type specimen of *V. bogerti* (Mertens 1950). Only the head of the holotype specimen was black and white depicted by Sprackland (1991). This author also incorrectly claimed that Mertens (1959) had examined a specimen from Rossel Island, which he identified as *V. (prasinus) bogerti*.

By contrast, Sprackland (1991) asserted that the holotype of *V. telenesetes* “bears no resemblance [sic] to *bogerti*” and, “aside from the distinct colouration,” mentioned some further morphological differences to distinguish both tree monitor taxa. However, in the cladogram presented by Sprackland (1991), *V. bogerti* and *V. telenesetes* are revealed as sister taxa. Because of these taxonomic uncertainties, it is reasonable to suggest that *V. telenesetes* may actually represent a junior synonym of *V. bogerti* Mertens, 1950. Re-examination of the type specimens of both rare monitor lizard taxa seems necessary to resolve this question.

**Conservation status.**—Since 2010, *V. telenesetes* has been classified as “data deficient” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus telenesetes*. 2010c. Available from <http://www.iucnredlist.org/apps/redlist/details/178388/0> [Accessed 09 December 2011]). The species is listed in Appendix II of CITES. In 2004, Papua New Guinea exported four specimens for scientific purposes. No other trade record was compiled in the CITES Trade Database (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Specific threats to *V. telenesetes* are not known (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus telenesetes*. 2010c. *op. cit.*). Given the case that taxonomic uncertainties can be ruled out in the future,





**FIGURE 41.** *Varanus auffenbergi* from Roti Island off the coast of Timor in the Lesser Sunda Islands. Note the bluish ocelli on the dorsum which distinguishes this taxon from *V. timorensis* (Fig. 41). (Photographed by Pauli Hien).



**FIGURE 42.** *Varanus similis* was described as a subspecies of *V. timorensis* (Fig. 43) but is now considered a distinct species. However, the systematics of these monitor lizards yet need to be solved. (Photographed by Mark O'Shea).



**FIGURE 43.** *Varanus timorensis* from Lospalos, Lautém District, Timor-Leste. Members of the subgenus *Odatria* have a tail that is round in cross section but not prehensile. (Photographed by Mark O'Shea).

it is important to implement conservation measures to secure this endemic monitor lizard species.

#### **Subgenus *Odatria* GRAY, 1838**

1838 *Odatria* GRAY, Annals of natural History, London, 1:394. – Type species (by monotypy): *Varanus tristis* (Schlegel, 1844).

1843 *Cylindrurus* FITZINGER, Systema Reptilium 1:19. – Type species (by original designation): *Varanus tristis* (Schlegel, 1844).

1843 *Agalmatosaurus* FITZINGER, Systema Reptilium 1:19. – Type species (by original designation): *Varanus timorensis* (Gray, 1831).

**Distribution.**—Australia, New Guinea, Timor and off-shore islands.

**Comments.**—The subgenus *Odatria* of monitor lizards underwent a major radiation on the Australian continent, which currently comprises 20 different species. Only three members of this subgenus, i.e., *V. auffenbergi* (Fig. 41), *V. similis* (Fig. 42), and *V. timorensis* (Fig. 43), inhabit islands of the Indo-Australian Archipelago.

#### ***Varanus timorensis* species group:**

**Comments.**—The taxonomy of the *V. timorensis* species group is far from resolved. This assemblage of closely related monitor lizards of the subgenus *Odatria* deserves a thorough taxonomic re-investigation. Meanwhile, however, it is clear that the former



subspecies *similis* and *scalaris* are not conspecific with *timorensis* (Branch 1982; Böhme 1988a; Ziegler and Böhme 1997). Certainly, several undescribed taxa, either full species or subspecies, are involved.

***Varanus timorensis* (GRAY, 1831)** (Fig. 43)

1831 *Monitor Timorensis* GRAY in GRIFFITH, The Animal Kingdom, Synopsis, 9:26. – Type locality: Timor.

1836 *Varanus Timoriensis* DUMERIL & BIBRON, *Erpétologie générale*, 3:473. – Type locality: Timor.

**Type specimens.**—Syntypes MNHN 8278 and 8278A (Brygoo 1987).

**Distribution.**—Timor and some small offshore islands such as Savu, Semau, and Kisar.

**Comments.**—This monitor lizard surely represents a (sub)species complex (Bennett 1998; Böhme 2003; King and Smith 2004). The population of Roti Island was described as a new species by Sprackland (1999). Brandenburg (1983) even reports a specimen of *V. timorensis* (RMNH 6949) from “Celebes” (= Sulawesi). This record, however, represents a mistake (André Koch, pers. obs.). Eight *timorensis* specimens from Seram deposited in the Bogor collection (MZB Lac. 1539) may also have erroneous locality data because Edgar and Lilley (1987) did not report the subgenus *Odatria* from that island.

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus timorensis* is listed in Appendix II of CITES. Interestingly, more than 6,300 leather products of *V. timorensis* have been exported and claimed to originate from Bangladesh and India in the period 1978 to 1982. Live specimens originating and exported from Indonesia exceed 9,000 specimens, of which > 8,300 Indonesia claimed captive-bred, 470 as farmed and 79 wild-caught (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*).

The species is nationally protected in Indonesia and is, thus, not subject to an annual quota system. Accordingly, only F2 stock can be destined for exports (Auliya 2009; see comments for *V. prasinus*). As of March 2006, *V. timorensis* stock documented by registered reptile breeding operations contained 39 wild, 118 F1 and 402 F2 stock, the latter of which all referred to one company (Table 3). However, a survey at this facility could not provide evidence for successful breeding *V. timorensis* (Auliya 2009; Nijman and Shepherd 2009). These authors therefore concluded that all specimens exported as captive-bred are in fact wild-caught. Other specific threats to the species appear undocumented. However, as a result of other faunal inventories and threats described, it seems likely that an increasing deforestation rate along with slash-and-burn agriculture (Trainor et al. 2008; Kaiser

et al. 2011) may contribute to a decline of *V. timorensis*.

***Varanus auffenbergi* SPRACKLAND, 1999** (Fig. 41)

1999 *Varanus auffenbergi* SPRACKLAND, *Reptile Hobbyist*, 4(6):22. – Type locality: Roti Island near Timor, Indonesia.

**Type specimens.**—Holotype AMNH 143812, paratypes AMNH 143813 and a specimen without collection number that was alive at the time of the species description.

**Distribution.**—Restricted to the type locality.

**Comments.**—While Sprackland (1999) described the taxon *auffenbergi* as a separate species of the *V. timorensis* complex, other authors consider this decision to be premature (Böhme 2003; King and Smith 2004).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *Varanus auffenbergi* is listed in Appendix II of CITES. The CITES Trade Database documents no trade of this species (Table 3). It is, therefore, very likely that this taxon was traded as *V. timorensis* prior to its description, for which trade records are documented since 1978 (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Regardless of the taxonomic status this monitor lizard population has, it certainly deserves appropriate conservation measures. Roti Island has become generally known because of the endemic Roti Island Snake-necked Turtle *Chelodina mccordi* (Rhodin 1994). Thus, wildlife trade structures are existent on this remote island (Shepherd and Ibarondo 2005). Other potential threats to this endemic island species are currently not known.

***Varanus similis* MERTENS, 1958** (Fig. 42)

1958 *Varanus (Odatria) timorensis similis* MERTENS, *Senckenbergiana biologica*, 39(5/6):239. – Type locality: Groote Eylandt, Carpentaria Bay, Northern Territory, Australia.

1982 *Varanus similis* - BRANCH, *Journal of Herpetology*, 16:37.

2004 *Varanus (Odatria) scalaris similis* - SMITH, SWEET & KING, in PIANKA & KING, *Varanoid Lizards of the World*:452.

**Type specimens.**—Holotype AMS R10207, paratypes SMF 54506 (formerly AMS R10206), SMF 11634, SMF 54511, ZMB 5775, BMNH 1926.2.25.58-59, BMNH 1908.2.25.4-6 (3 spec.), BMNH 1903.10.19.11-13, BMNH 64.5.13.23, BMNH 82.3.27.12, BMNH 81.10.12.2, BMNH 78.10.16.33-34, BMNH 1926.2.25.49-50, BMNH 1.5.a, BMNH 84.9.13, and four uncatalogued specimens in BMNH.



FIGURE 44. *Varanus salvadorii* is the largest monitor lizard of New Guinea and the only representative of the endemic subgenus *Papusaurus*. (Photographed by Mark Auliya).

**Distribution.**—Queensland, Northern Australia, and off-coast islands in the Torres Strait as well as southern New Guinea.

**Comments.**—*Varanus similis* has a complicated taxonomic history. Originally described as a subspecies of *V. timorensis* (Fig. 41), it was elevated to full species status due to differences in hemipeneal morphology (Branch 1982; Böhme 1988a; Ziegler and Böhme 1997). Currently, the taxon *similis* is considered a subspecies of *V. scalaris* (Fitch et al. 2006), a species likely to include several new taxa (see Smith et al. 2004). We here follow former authors, who already treated *V. similis* as full species.

**Conservation status.**—The IUCN Red List does not recognize the taxonomic uncertainty in this species, but does not assess *V. similis*. Instead, *V. scalaris* has been referred to and classified as “least concern” (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus scalaris*. 2010d. Available from <http://www.iucnredlist.org/apps/redlist/details/178032/0> [Accessed 10 December 2011]). *Varanus similis* is listed in Appendix II of CITES. Since 1978 until 2010 the CITES Trade Database documents trade in *V. similis*. Between 1991 and 1998 Indonesia claimed the export of > 1,820 wild specimens and between 2008 and 2009 the country exported 253 farmed specimens of *V. similis*. Another > 350 individuals were reported by importing countries as exports from Indonesia with the majority sourced from the wild (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Australian populations may be threatened by fire regimes occurring in savannah woodlands (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., and S.S. Sweet. *Varanus scalaris*. 2010d. *op. cit.*). At present no direct threats

are known to impact on populations native to southern New Guinea.

#### Subgenus *Papusaurus* MERTENS, 1962

1962 *Papusaurus* MERTENS, *Senckenbergiana biologica*, 43:331. – Type species: *Varanus salvadorii* (Peters & Doria, 1878).

**Distribution.**—Restricted to New Guinea.

**Comments.**—The monotypic subgenus *Papusaurus* contains only one species, *V. salvadorii* (Fig. 44). Mertens (1962) erected this subgenus for the Crocodile monitor of New Guinea due to morphological autapomorphies. Genetically, however, *V. salvadorii* is closely related to *V. komodoensis* (Fig. 2) and *V. varius* of the subgenus *Varanus* (Ast 2001; Fitch et al. 2006), thus rendering the latter paraphyletic. Given the close genetic proximity on the one hand and the morphological distinctiveness of *V. salvadorii* on the other hand, the validity of a monotypic subgenus *Papusaurus* must be reconsidered. However, as the subgenus *Varanus* shows a deep genetic split, which points towards two independent evolutionary lineages within *Varanus* (Ast 2001; Fitch et al. 2006), premature synonymizations should be avoided.

*Varanus salvadorii* (PETERS & DORIA, 1878) (Fig. 44)

1878 Monitor *Salvadorii* PETERS & DORIA, *Annali del Museo Civico di Storia Naturale di Genova*, 13:337. – Type locality: Dorei, West Papua, New Guinea, Indonesia.

**Type specimen.**—Holotype MSNG 28726.

**Distribution.**—New Guinea.

**Comments.**—Based on anecdotal reports *Varanus salvadorii* exceeds four meters in total length but this has never been substantiated (Schmicking and Horn 1997). Populations in northern and southern New Guinea appear morphologically distinct (Mark Auliya, pers. obs.).

**Conservation status.**—The species as yet has not been assessed in the IUCN Red List. *Varanus salvadorii* is listed in Appendix II of CITES. While the species is protected in PNG, Indonesia has allocated annual export quotas of the species (Table 2). Since 2001, the trade of wild specimens from Indonesia into the European Union has been suspended (UNEP-WCMC 2009). In the period 1987 to 2010, Indonesia exported 4,834 live specimens of *V. salvadorii*, of which 3,559 were claimed wild (74%) and 432 specimens farmed (9%; Table 3). Interestingly, within the period of trade suspension, several EU countries did document the import of wild



**FIGURE 45.** *Varanus mabitang* is one of three frugivorous monitor lizards from the Philippines. This endemic species is threatened by habitat destruction. (Photographed by Maren Gaulke).



**FIGURE 46.** Head portrait of *Varanus mabitang*. Note the slit-like nostril in this species (red arrow). (Photographed by Maren Gaulke).

specimens (in some shipments via the United States). These are the Czech Republic, Spain, France, Great Britain and Germany (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Some countries of destination reported the import of captive-bred specimens from Indonesia.

Aside the impact of the international pet trade the species is locally also harvested for its meat and eggs (Allison 2006). Despite its wide geographic range, *V. salvadorii* is characterized as uncommon and rare (Allison 2006; Pattiselanno et al. 2007). Illegal logging activities and the concomitant expansion of oil palm plantations as well as commercial mining operations (The World Bank 2006; Yeager 2008; Colchester et al. 2011) may result in a fragmentation of populations and decline of the species.

#### **Subgenus *Philippinosaurus* MERTENS, 1959**

1959 *Philippinosaurus* MERTENS, *Senckenbergiana biologica*, 40:228. – Type species: *Varanus grayi* Boulenger, 1885 = *Varanus olivaceus* Hallowell, 1856.

**Distribution.**—Restricted to the Philippine islands of Luzon and Panay.

**Comments.**—The subgenus *Philippinosaurus* comprises the only frugivorous monitor lizard species that feed mainly on leaves and fruits. All three species are endemic to the Philippines.

#### ***Varanus bitatawa* WELTON, SILER, BENNETT, DIESMOS, DUYA, DUGAY, RICO, VAN WEERD & BROWN, 2010**

2010 *Varanus bitatawa* WELTON, SILER, BENNETT, DIESMOS, DUYA, DUGAY, RICO, VAN WEERD & BROWN, *Biology Letters*, 6:654. – Type locality: Base of the San Ildefonso Peninsula, Sitio Casapsipan, Barangay Casiguran, Municipality of Casiguran, Aurora Province, Luzon Island, Philippines.

**Type specimens.**—Holotype PNM 9719 (formerly KU 320000), paratypes KU 322188 and PNM 9008.

**Distribution.**—Northern Luzon, Philippines.

**Comments.**—This species was recently separated from *V. olivaceus* mainly based on genetic differences (Welton et al. 2010).

**Conservation status.**—The species has not been assessed in the IUCN Red List. *V. bitatawa* is listed in Appendix II of CITES. Due to its new discovery in 2010, trade remains undocumented within the CITES Trade Database (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). According to Gaulke (2010), on-going illegal logging of lowland evergreen forests next to slash-and-burn activities may contribute to a decline and extinction of this Philippine monitor.

***Varanus mabitang* GAULKE & CURIO, 2001** (Figs. 45, 46)

2001 *Varanus mabitang* GAULKE & CURIO, *Spixiana* 24(3):277. – Type locality: South Pandan Forest, Antique Province, Panay Island, Philippines.

**Type specimen.**—Holotype PNM 7272.

**Distribution.**—Restricted to Panay Island.

**Comments.**—The melanistic *V. mabitang* was only recently discovered.

**Conservation status.**—Since 2010, *V. mabitang* is classified as “endangered” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Gaulke, M., A. Diesmos, A. Demegillo, and J.C. Gonzalez. *Varanus mabitang*. 2009a. Available from <http://www.iucnredlist.org/apps/redlist/details/169829/0> [Accessed 10 December 2011]). *Varanus*





**FIGURE 47.** *Varanus olivaceus* from the Philippines at a reptile trader on Bali. The endemic CITES Appendix II monitor lizard species is also sought after because in traditional beliefs specific body parts are said to possess medicinal properties. (Photographed by Mark Auliya).



**FIGURE 48.** Due to its colorful appearance *Varanus c. cumingi* from the southern Philippines is in demand of the international pet trade. The dark blue tongue is typical for all water monitor lizards. (Photographed by Maren Gaulke).



**FIGURE 49.** *Varanus cumingi samarensis* from Leyte Island shows less yellow coloration than the nominotypic subspecies. The dorsal markings are arranged in more or less well defined ocelli rather than continuous transverse bands. (Photographed by Maren Gaulke).



**FIGURE 50.** A juvenile of *Varanus cumingi samarensis* from Samar Island. (Photographed by Maren Gaulke).

*mabintang* is listed in Appendix II of CITES. Since its description in 2001 (Gaulke and Curio 2001), only one transaction is documented [i.e., in 2005, Germany allegedly imported 25 wild specimens (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*)]. Actually, only small numbers of claws were imported for isotope analyses (Gaulke et al. 2007). Current information on the population status suggests a decreasing trend, due to the clearing of forest habitats and conversion to farmland (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2010.4. Gaulke, M., A. Diesmos, A. Demegillo, and J. C. Gonzalez. 2007. *Varanus mabintang*. Available from <http://www.iucnredlist.org/apps/redlist/details/169829/0> [Accessed 12 January 2011]). It has also been reported that this large-sized species is sought-after for consumption. Thus, subsistence hunting must also be considered a serious threat to the survival of *V. mabintang*

(International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Gaulke, M., A. Diesmos, A. Demegillo, and J.C. Gonzalez. *Varanus mabintang*. 2009a. *op. cit.*).

***Varanus olivaceus* HALLOWELL, 1856 (Fig. 47)**

1845 *Uranus ornatus* GRAY (non *Tupinambis ornatus* DAUDIN, 1803), Catalogue of the Lizards in the British Museum:10. – Type locality: Philippines.

1856 *Varanus olivaceus* HALLOWELL, Proceedings of the Academy of natural Sciences of Philadelphia 8:150. – Type locality: “Manilla” = Manila, Luzon, Philippines.

1885 *Varanus grayi* BOULENGER (new name for *Uranus ornatus* GRAY, 1845), Catalogue of the Lizards in the British Museum 2:312. – Type locality: Philippines.

1959 *Varanus (Philippinosaurus) grayi* – MERTENS, Senckenbergiana biologica, 40:229.

1988 *Varanus olivaceus* – AUFFENBERG, Gray's monitor lizard:3.

**Type specimen.**—Holotype ANSP 9916, presumed lost (Pianka 2004b).

**Distribution.**—Southern Luzon, Catanduanes, and Polillo islands, Philippines.

**Comments.**—Originally, Gray (1845) described the monitor lizard, which is today known as *V. olivaceus* under the name of *Uaranus ornatus*. Forty years later, Boulenger (1885) realized that the name *ornatus* was preoccupied by *Tupinambis ornatus* Daudin, 1803 (= *Varanus ornatus* [Daudin, 1803]) from Africa and re-described the species under the new name *Varanus grayi*. Hallowell (1856), however, had given the name *V. olivaceus* to the same Philippine monitor species, which was overlooked by subsequent authors until Auffenberg (1988) recognized this omission. Therefore, the older *V. olivaceus* has priority over *V. grayi*.

**Conservation status.**—*Varanus olivaceus* is classified as “vulnerable” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Sy, E., L. Afuang, M.R. Duya, and M. Diesmos. 2009a. *Varanus olivaceus*. Available from <http://www.iucnredlist.org/apps/redlist/details/22888/0> [Accessed 10 December 2011]). The species is listed in Appendix II of CITES. Since 1978 to 2010, the CITES Trade Database documents the export of 21 specimens. Importing countries, however, reported 44 specimens being shipped in the same period (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). The population trend of *V. olivaceus* is perceived as decreasing with forest loss, land use and hunting identified as major threats (Auffenberg 1988; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Sy, E., L. Afuang, M.R. Duya, and M. Diesmos. 2009a. *Varanus olivaceus. op. cit.*). The species is not only utilized for its flesh (Auffenberg 1988). According to traditional beliefs specific body parts also possess medicinal properties. Auffenberg (1988) estimated that approximately 240 specimens were harvested per year.

### **Subgenus *Soterosaurus* ZIEGLER & BÖHME, 1997**

1830 *Hydrosaurus* WAGLER, *Natürliches System der Amphibien*:132,140. – Type species: *Varanus salvator bivittatus* (Kuhl, 1820) (not *Hydrosaurus* Kaup, 1828: Agamidae)

1997 *Soterosaurus* ZIEGLER & BÖHME, *Mertensiella*, 8:176. – Type species: *Varanus salvator* (Laurenti, 1768).

**Distribution.**—From Sri Lanka through continental and insular Southeast Asia including the Philippines as well as the Greater and Lesser Sunda Islands, Sulawesi, and the northern Moluccas.

**Comments.**—Until recently, the subgenus *Soterosaurus* comprised only one widespread polytypic species, the Southeast Asian Water Monitor, *V. salvator*. Recently, several subspecies (i.e., *cumingi*, *nuchalis*, *marmoratus*, and *togianus*) were elevated to full species rank (Koch et al. 2007) and two new species from the Philippines, viz. *V. palawanensis* (Fig. 54) and *V. rasmusseni* (Fig. 55), have been described (Koch et al. 2010b), bringing the species number of the subgenus *Soterosaurus* to seven. Further taxonomic additions are to be expected as systematic investigations continue. Only recently, *V. salvator* was encountered on some Moluccan islands (Weijola 2010; Weijola and Sweet 2010). Thus, the historical records from Halmahera Islands (see Müller and Schlegel 1845; Brandenburg 1983; Koch et al. 2007) become more likely to be correct but still need confirmation.

### ***Varanus cumingi* MARTIN, 1838** (Figs. 48–50)

1838 *Varanus cumingi* MARTIN, *Proceedings of the zoological Society of London*, 1838:69. – Type locality: Mindanao, Philippines.

1942 *Varanus (Varanus) salvator cumingi* - MERTENS, *Abhandlungen der Senckbergischen naturforschenden Gesellschaft*, 466:256.

2007 *Varanus (Soterosaurus) cumingi* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME, *Mertensiella*, 16:168.

**Distribution.**—Islands of the Greater Mindanao region (i.e., Mindanao, Samar, Leyte, and Bohol), Philippines.

**Comments.**—Recently, *V. cumingi* was demonstrated to be polytypic and a new subspecies was described from the northern islands of the species range (Koch et al. 2010b). The taxonomic status of the populations from Basilan, Dinagat, and Siargao is unclear.

**Conservation status.**—The species is classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Sy, E., A. Diesmos, P.G. Jakosalem, J.C. Gonzalez, L.M. Paguntalan, A. Demegillo, C. Custodio, E. Delima, G. Tampos, M. Gaulke, and R. Jose. *Varanus cumingi*. 2009b. Available from <http://www.iucnredlist.org/apps/redlist/details/169897/0> [Accessed 10 December 2011]) *V. cumingi* is listed in CITES Appendix II. The Philippines together with Thailand is the major exporter of skins after Indonesia (Gaulke 1998). Trade data of *V. salvator cumingi* was retrieved from 1982 to





**FIGURE 51.** *Varanus* cf. *marmoratus* from Mindoro Island showing the enlarged nuchal scales, which are characteristic for all water monitor species of the Philippines. This population probably represents another undescribed taxon of the *V. salvator* complex. (Photographed by Maren Gaulke).



**FIGURE 52.** *Varanus nuchalis* from Panay shows varying degree of white markings on head and body. Also entirely black specimens occur. (Photographed by Maren Gaulke).

2010 (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). In this period, > 31,000 skins were exported from the Philippines. In contrast, importing countries (particularly Japan > 80%) reported > 150,000 skins. No trade is documented in the period 2001–2009. In addition, the CITES Trade Database documents exports of *V. salvator* from the Philippines without specifying island populations (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). Between 1987 and 2004, another > 5,800 skins were exported, while importing documents were issued for > 172,000 *V. (salvator) cumingi* skins from the Philippines. Besides the export of skins, thousands of leather products are documented. The species is also harvested across its range for human consumption purposes (Gaulke 1998; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Sy, E., A. Diesmos, P.G. Jakosalem, J.C. Gonzalez, L.M. Paguntalan, A. Demegillo, C. Custodio, E. Delima, G. Tampos, M. Gaulke, and R. Jose. *Varanus cumingi*. 2009b. *op. cit.*). Habitat loss followed by large-scale logging and mining activities is a major issue in eastern Mindanao (CEPF 2001).

***Varanus c. cumingi* MARTIN, 1838** (Fig. 48)

1838 *Varanus cumingi* MARTIN, Proceedings of the zoological Society of London, 1838:69. – Type locality: Mindanao, Philippines.  
1991 *Varanus salvator cumingi* - GAULKE (in part), Mertensiella, 2:154.

**Type specimen.**—Lectotype BMNH 1946.8.31.5, by designation of Koch et al. (2007).

**Distribution.**—Restricted to Mindanao and off-shore islands, Philippines.

**Conservation status.**—See comments above.

***Varanus cumingi samarensis* KOCH, GAULKE & BÖHME, 2010** (Figs. 49, 50)

1991 *Varanus salvator cumingi* - GAULKE (in part), Mertensiella, 2:161.

2010 *Varanus cumingi samarensis* KOCH, GAULKE & BÖHME, Zootaxa, 2440:19 – Type locality: San Augustin near Gandara, Samar Island, Philippines.

**Type specimens.**—Holotype ZFMK 64713, paratype ZFMK 64712.

**Distribution.**—Samar, Bohol, and Leyte, Philippines.

**Conservation status.**—A first assessment has been provided for the species (see above). However, due to the much smaller range of *V. cumingi samarensis*, it is important to identify potential threats this subspecies is subject to, such as logging of mangrove forests in Samar Island (Mendoza and Alura 2001).

***Varanus marmoratus* (WIEGMANN, 1834)** (Fig. 51)

1829 *M[onitor] marmoratus* CUVIER, Règne animal 2(2):26. (nomen nudum according to Mertens [1942] and Good et al. [1993]).

1834 *Hydrosaurus marmoratus* WIEGMANN, in MEYEN, Reise um die Erde, 3:446. – Type locality: San Mat(h)eo village and Talim Island, Laguna Bay, near Manila, Luzon, Philippines.

1844 *Monitor bivittatus philippensis* SCHLEGEL, Abbildungen Amphibien: x. – Type locality: Manila, Luzon.

1876 *Varanus manilensis* VON MARTENS, Preussische Expedition nach Ost-Asien, Zoologie, 1:196. (Lapsus according to Mertens [1942]).

1942 *Varanus (Varanus) salvator marmoratus* - MERTENS, Abhandlungen der Senckbergischen naturforschende Gesellschaft, 466:254.



1944 *Varanus salvator philippinensis* DERANIYAGALA, Spolia Zeylanica, 24:61. – Type locality: Luzon.

1997 *Varanus (Soterosaurus) salvator marmoratus* - ZIEGLER & BÖHME, Mertensiella, 8:177.

2007 *Varanus (Soterosaurus) marmoratus* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME, Mertensiella, 16:161.

**Type specimens.**—Lectotype ZMB 470, designated by Mertens (1942). Originally, Wiegmann (1834) based his description on two voucher specimens (Koch et al. 2007). The second larger syntype, however, which should have paralectotype status, is missing (Good et al. 1993).

**Distribution.**—Restricted to Luzon and some off-shore islands, Philippines.

**Comments.**—Recently, *V. marmoratus* was shown to represent a collective species (Koch et al. 2010b). The disjunct island populations of the Greater Palawan Region and the Sulu Archipelago were allocated to two new species (see below). The taxonomic status of the Mindoro population deserves further investigation (Koch et al. 2010b).

**Conservation status.**—The species is classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Gaulke, M., E. Sy, L. Afuang, M.R. Duya, M. Diesmos, and J.C. Gonzalez. *Varanus marmoratus*. 2009b. Available from <http://www.iucnredlist.org/apps/redlist/details/169844/0> [Accessed 10 December 2011]). *Varanus marmoratus* is listed in Appendix II of CITES. The only trade data which could be retrieved from the CITES Trade Database documents trade in 2009 and 2010, with the Philippines exporting 15 wild specimens to the US (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). However, international trade

volumes likely may be much higher (see *V. cumingi*). *Varanus marmoratus* is locally also sought-after for consumption purposes (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Gaulke, M., E. Sy, L. Afuang, M.R. Duya, M. Diesmos, and J.C. Gonzalez. *Varanus marmoratus*. 2009b. *op. cit.*). These authors reported stable populations over the species range. Further potential threats are described above (see *V. bitatawa*).

***Varanus nuchalis* (GÜNTHER, 1872)** (Figs. 52, 53)

1872 *Hydrosaurus nuchalis* GÜNTHER, Proceedings of the Zoological Society of London, 1872:145. – Type locality: “Philippines”.

1942 *Varanus (Varanus) salvator nuchalis* - MERTENS, Abhandlungen der Senckbergischen naturforschenden Gesellschaft, 466:258.

1997 *Varanus (Soterosaurus) salvator nuchalis* - ZIEGLER & BÖHME, Mertensiella, 8:177.

2007 *Varanus (Soterosaurus) nuchalis* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME, Mertensiella, 16:165.

**Type specimen.**—Holotype BMNH 1946.9.1.17.

**Distribution.**—Islands of Negros, Panay, Masbate, Ticao, and Cebu, Philippines.

**Comments.**—Despite a high variation in color patterns, a recent study could not document a correlation between color pattern and distribution (Koch et al. 2010b). Therefore, *V. nuchalis* remains monotypic.

**Conservation status.**—The species is classified as “near threatened” in the IUCN Red List (IUCN, IUCN Red List of Threatened Species, Version 2011.2. Diesmos, A., and M. Gaulke. 2009. *Varanus nuchalis*. Available from <http://www.iucnredlist.org/apps/>



FIGURE 53. A vividly colored hatchling of *Varanus nuchalis*. (Photographed by Maren Gaulke).



FIGURE 54. *Varanus palawanensis* from Palawan Island was long unrecognized as a separate species and allocated to *V. marmoratus* (Fig. 51). This specimen was found in the Puerto Princesa National Park. (Photographed by Rachel Franco).



**FIGURE 55.** The juvenile paratype of *Varanus rasmusseni* (ZFMK 89391, formerly ZMUC R42153, field number E136) from Tawi-Tawi Island, Sulu Archipelago, Philippines. Note the color pattern of many small bright spots scattered across the dorsum, which is unique among the members of the *V. salvator* complex but fades in adults. (Photographed by André Koch).



**FIGURE 56.** This subadult specimen of *Varanus s. salvator* from Bentota Ganga, Sri Lanka, shows the characteristic dorsal color pattern of well-defined ocelli. (Photographed by Dieter Gramentz).

[redlist/details/169767/0](#) [Accessed 10 December 2011]). *Varanus nuchalis* is listed in Appendix II of CITES. No trade data is recorded by the CITES Trade Database (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*), although international trade in this species is reported (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Diesmos, A., and M. Gaulke. *Varanus nuchalis*. 2009. *op. cit.*). According to these authors, subsistence hunting has been reported as a local threat to populations. The species is found in various habitats and appears to also persist in disturbed habitats (Ferner et al. 2000).

***Varanus palawanensis* KOCH, GAULKE & BÖHME, 2010** (Fig. 54)

1942 *Varanus (Soterosaurus) marmoratus* - MERTENS (in part), *Abhandlungen der Senckbergischen naturforschenden Gesellschaft*, 466:254.

1991 *Varanus salvator marmoratus* - GAULKE (in part), *Mertensiella*, 2:154.

2007 *Varanus (Soterosaurus) marmoratus* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME (in part), *Mertensiella*, 16:161.

2010 *Varanus palawanensis* KOCH, GAULKE & BÖHME, *Zootaxa*, 2446:33. – Type locality: Tabon, Palawan Island, Philippines.

**Type specimens.**—Holotype SMF 73912, paratypes SMF 73914–915, BMNH 94.6.30.19, BMNH 94.6.30.20, MNHN 1884-187, ZMUC E78, and ZFMK 89691 (formerly SMF 73913).

**Distribution.**—Islands of Greater Palawan (Palawan, Balabac and the Calamian Island group) and Sibutu Island within the Sulu Archipelago, Philippines.

**Comments.**—The monitor lizard population of Palawan and adjacent islands was traditionally allocated to *V. marmoratus* (Fig. 51). Recent investigations, however, confirmed the morphological distinctness at species level (Koch et al. 2010b).

**Conservation status.**—The species has not yet been assessed in the IUCN Red List. *Varanus palawanensis* is listed in Appendix II of CITES. Due to the recent taxonomic description, neither trade data nor species-specific threats are documented. However, like many other Philippine islands, Palawan's biodiversity is subject to a variety of threats such as illegal logging for timber, exploitation of rattan, swidden farming, and harvesting of bush meat (Widman 1998; Boissière, M., and N. Liswanti. 2006. Biodiversity in a Batak village of Palawan (Philippines) – A multidisciplinary assessment of local perceptions and priorities. Available from [http://www.cifor.org/lpf/docs/publications/reports/year3/lpf\\_02\\_2006.pdf](http://www.cifor.org/lpf/docs/publications/reports/year3/lpf_02_2006.pdf) [Accessed 23 November 2011]).

***Varanus rasmusseni* KOCH, GAULKE & BÖHME, 2010** (Fig. 55)

1992 *Varanus salvator marmoratus* - Gaulke (in part), *Hamadryad*, 17:21.

2007 *Varanus (Soterosaurus) cf. marmoratus* - Koch, Auliya, Schmitz, Kuch & Böhme, *Mertensiella*, 16:163.

2010 *Varanus rasmusseni* Koch, Gaulke & Böhme, *Zootaxa*, 2446:28. – Type locality: Tarawakan, north of Batu-Batu, Tawi-Tawi Island, Sulu Archipelago, Philippines.

**Type specimens.**—Holotype ZMUC R42151, paratype ZFMK 89391 (formerly ZMUC R42153).

**Distribution.**—Only known from the type locality, but probably also on other islands of the Tawi-Tawi island group.

**Comments.**—Recent morphological investigations demonstrated the specific distinctness of the Tawi-Tawi population which was formerly assigned to *V. marmoratus* (Koch et al. 2010b). The newly described *V. rasmusseni* is known only from the two type specimens.

**Conservation status.**—The species has not yet been assessed in the IUCN Red List. *Varanus rasmusseni* is listed in CITES Appendix II. Due to its recent description, neither trade data nor species-specific threats are documented for *V. rasmusseni*. However, the fact that this monitor species has a very restricted distribution range may mean that any potential threat to which the population is exposed to could result in the extinction of this species.

***Varanus salvator* (LAURENTI, 1768)** (Figs. 56–61)  
1768 *Stellio salvator* Laurenti, Synops. Rept.: 56. – Type locality: Sri Lanka (designated by Mertens 1959; confirmed by Koch et al. 2007).

**Distribution.**—From Sri Lanka through continental and insular Southeast Asia including the Greater and Lesser Sunda Islands, northern Sulawesi, and the northern Moluccas.

**Comments.**—Currently, *V. salvator* is a polytypic species with five subspecies. In addition, for the northern Sulawesi population the name *celebensis* Schlegel, 1844 is available and further hitherto unnamed water monitor taxa are awaiting their formal description.

**Conservation status.**—The species is classified as “least concern” in the IUCN Red List (International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2011.2. Bennett, D., M. Gaulke, E.R. Pianka, R. Somaweera, and S.S. Sweet. *Varanus salvator*. 2010. Available from <http://www.iucnredlist.org/apps/redlist/details/178214/> [Accessed 11 December 2011]). *Varanus salvator* is listed in Appendix II of CITES (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). For the past few decades, this widespread monitor lizard species has been the world’s most heavily exploited species in terms of skin volumes internationally traded on a commercial scale (Luxmoore and Groombridge 1990; Auliya 2006). In the period from 2000–2010, almost 10 million *V. salvator* skins were exported, with Indonesia (63%) and Malaysia (33%) representing the major exporting countries (Table 3; see also Traeholt 1998). Indonesia has allocated very high annual export quotas for this species (see Table 2). Across the species range, *V. salvator* is also hunted and traded



FIGURE 57. *Varanus salvator bivittatus* from Java. (Photographed by Dietmar Trobisch).

for consumption purposes and more rarely for traditional medicine (e.g., Luxmoore and Groombridge 1990; Johnson et al. 2003; Li et al. 2008). The intense and continuous annual off-take levels in parts of peninsula Malaysia and Indonesia do indicate that local populations are declining (Auliya 2006; Department of Wildlife and National Parks [DWNP] Peninsular Malaysia, pers. comm. to Mark Auliya). However, it remains difficult to ascertain whether current exploitation levels impact local *V. salvator* populations, or if other factors such as specific land use practices not in favor of this semi-aquatic monitor lizard species also add to these declines.

***Varanus s. salvator* (LAURENTI, 1768)** (Fig. 56)  
1758 *Lacerta monitor* part. LINNAEUS, Systema naturae, 10(1):201. – Type locality: In Indiis (nomen rejectum according to ICZN 1959).  
1768 *Stellio salvator* LAURENTI, Synopsin Reptilium:56. – Type locality (designated by Mertens 1959; confirmed by Koch et al. 2007): Sri Lanka.  
1947 *Varanus salvator kabaragoya* DERANIYAGALA, Proceedings of the 3rd annual Session of the Ceylon Association of Sciences, 2 (Abstr.):12. – Type locality: “Ceylon” (= Sri Lanka).  
1997 *Varanus (Soterosaurus) salvator salvator* - ZIEGLER & BÖHME, Mertensiella, 8:177

**Type specimen.**—Neotype ZFMK 22092 (designated by Koch et al. 2007).

**Distribution.**—Restricted to the type locality.

**Comments.**—Until recently the nominotypic subspecies had the widest distribution range within the widespread *V. salvator* complex. Due to the revalidation of *V. s. macromaculatus* from continental Southeast Asia, the nominotypic subspecies is now restricted to Sri Lanka.

**Conservation status.**—For a general assessment of the subspecies see *V. salvator*. The nominate form appears to be widespread in all suitable habitats and





FIGURE 58. *Varanus salvator macromaculatus* from Tioman Island, Malaysia, reaches total lengths of up to three meters in continental Southeast Asia. (Photographed by Pauli Hien).



FIGURE 59. The juvenile holotype of *Varanus salvator ziegleri* (SMF 56442) shows the typical color pattern of this subspecies consisting of well-developed light-centered ocelli on the dorsum that become less distinct toward the fore limbs. (Photographed by André Koch).

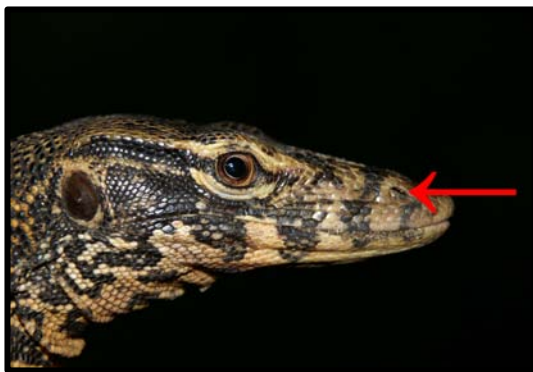


FIGURE 60. Head of *Varanus salvator* ssp. from Kalaotoa Island, Flores Sea, showing an oval nostril and the typical black bars (red arrow) on the snout. (Photographed by André Koch).



FIGURE 61. Dorsal view of the head of *Varanus salvator* ssp. from Kalaotoa Island, Flores Sea. Typically, the rectangular scales (in red) above the eyes (supraoculars) are enlarged compared with the remaining undifferentiated and irregularly shaped head scales (in green). (Photographed by André Koch).

was the first legally protected reptile in Sri Lanka (Karunaratna et al. 2008).

***Varanus salvator andamanensis* DERANIYAGALA, 1944**

1944 *Varanus salvator andamanensis* Deraniyagala, *Spolia Zeylan.*, 24: 61. – Type locality: 1997 *Varanus (Soterosaurus) salvator andamanensis* - Ziegler & Böhme, *Mertensiella*, 8:177 Port Blair, South Andaman Island, Andaman Islands, India.

**Type specimens.**—Holotype IM (Indian Museum, Calcutta) 2176, paratype IM 2174.

**Distribution.**—Restricted to the Andaman Islands.

**Conservation status.**—This subspecies of the water monitor is involved in the illegal international pet trade as was observed in Japan in 2007 (Mark Auliya, pers. obs.). Subsistence hunting of *V. salvator andamanensis* is reported (UNESCO 2010) and also occurs on the Nicobar Islands (Chandi 2006), but referring to populations of *V. salvator macromaculatus*. Current information on trade, next

to conservation issues such as road construction, immigration of mainlanders and encroachment (UNESCO 2010) suggests that the susceptible island ecosystems are under pressure. However, it cannot be judged at this stage whether these threats also contribute to a population decline of *V. salvator andamanensis*.

***Varanus salvator bivittatus* (KUHLE, 1820) (Fig. 57)**

1820 *Tupinambis bivittatus* KUHLE, *Beiträge zur Zoologie*:125. – Type locality (designated by Mertens 1959): Java, Indonesia.

1997 *Varanus (Soterosaurus) salvator bivittatus* - ZIEGLER & BÖHME, *Mertensiella*, 8:177

**Type specimen.**—Type unknown (Koch et al. 2007), “iconotype” plate 30, Fig. 2, in Seba’s (1735) “Thesaurus”.

**Distribution.**—Java and Lesser Sunda Islands, Indonesia.



FIGURE 62. *Varanus togianus* from the Togeian Islands, central Sulawesi, is dorsally unicolorous black. Juveniles, however, exhibit a dense pattern of small scattered yellow dots. (Photographed by André Koch).



FIGURE 63. Ventrally, *Varanus togianus* shows well-defined light and dark crossbands in contrast to other melanistic populations of the *V. salvator* complex, which are either entirely black colored or have an unpatterned bright ventral side. (Photographed by Kai Philipp).

**Comments.**—The *V. s. bivittatus* populations inhabiting the Lesser Sunda Islands show a high variation in color pattern. Their taxonomic status is under systematic investigations (André Koch et al., unpubl. data).

**Conservation status.**—For a general assessment of the subspecies see above. In 2008, Indonesia's annual export quota for *V. salvator* was 426,000 skins with

Java contributing 30,000 (7%) and the Lesser Sundas 12,000 (2.8%) skins (PHKA 2008). At present there is no information available about declining population trends of *V. s. bivittatus*.

***Varanus salvator macromaculatus* DERANIYAGALA, 1944** (Figs. 58, 70-72)

1802 *Tupinambis elegans* part. DAUDIN, Hist. nat. Rept., 3:36. – Type locality: “Surinam.”

1831 *Tupinambis exilis* GRAY in GRIFFITH, Anim. Kingd., 9:25. – Type locality: India (nomen dubium according to Koch et al. 2007).

1834 *Varanus vittatus* LESSON in BÉLANGER, Voyage Ind. Orient. Zool.:307. – Type locality: Indian subcontinent and islands at the mouth of the Ganges River (nomen dubium according to Koch et al. 2007).

1842 *Varanus binotatus* BLYTH, J. asiat. Soc. Bengal, 11: 867 (Lapsus according to Mertens 1942).

1942 *Lacertus tupinambis* part. MERTENS (non Lacépède, 1788) Abh. Senckb. Naturf. Ges., 466:245. – Type locality: unknown (Lapsus according to Brygoo 1987).

1944 *Varanus salvator macromaculatus* DERANIYAGALA, Spol. Zeyl. 24:60. – Type locality (restricted by Koch et al. 2007): “Siam” (= Thailand).

1947 *Varanus salvator nicobariensis* DERANIYAGALA, Proc. 3rd ann. Sess. Ceylon Assoc. Sci., 2, Abstr.: 12. – Type locality: Tillanchong, Nikobar Islands.

1987 *Varanus salvator komaini* NUTPHAND, J. Thai. Zool. Center, 2(15):51. – Type locality: “Sea shore areas and small islands in south western Thailand”.

2007 *Varanus (Soterosaurus) salvator macromaculatus* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME, Mertensiella, 16:136.

**Type specimens.**—Lectotype MNHN 871, paralectotype MNHN 1884.77.

**Distribution.**— Northern India, Burma (Myanmar), Thailand, Malaysian Peninsula, Cambodia, Laos, Vietnam, and southern China (Hainan) as well as Indonesia (Sumatra, and Borneo and the smaller off-shore islands Nias, Siberut, Simalur, Bangka, and Belitung).

**Comments.**—This subspecies of the water monitor was recently resurrected from the synonymy of the nominotypic taxon *s. salvator* (Fig. 56), which, due to differences in morphological characters and color pattern, had to be restricted to Sri Lanka (Koch et al. 2007), the designated type locality (Mertens 1959). At the same time, the melanistic taxon *komaini* from Thailand was demonstrated to be a junior synonym of *V. s. macromaculatus* in the absence of morphological differences except for the lack of a light color pattern.

**Conservation status.**—For a general assessment of the subspecies, see above. In 2008, Indonesia's annual





**FIGURE 64.** Next to the omnipresent threats by the pet and skin trades, monitor lizards (here *Varanus salvator* ssp.) fall frequently victim to local traffic and some are killed for human consumption or as a food competitor that may steal chickens. (Photographed by André Koch).



**FIGURE 65.** *Varanus spinulosus* is endemic to the Solomon Islands. Its systematic position within the genus *Varanus* is not yet solved. Note the relatively large eye of this species and the large yellow spots on the dorsum. (Photographed by Quetzal Dwyer).



**FIGURE 66.** Close-up of the spike-like neck scales of *Varanus spinulosus*. This morphological feature is characteristic for this monitor species. (Photographed by Nobuhiro Kawazoe).

export quota for skins of *V. salvator* was 426,000, of which Sumatra provided 267,000 (62%) and Kalimantan 145,000 (34%) skins (PHKA 2008). Together with the island quotas from Java and the Lesser Sunda Islands (see above), this adds up to 454,000 skins per year. Thus, the official annual quota was exceeded by 6%. Interestingly, specimens from Sulawesi and the Moluccas are not harvested. Decreasing population trends as aforementioned refer to this subspecies. Johnson et al. (2003) noted that the abundance of this taxon is decreasing in Laos.

***Varanus salvator ziegleri* KOCH & BÖHME, 2010**  
 (Fig. 59)

1959 *Varanus (Varanus) salvator salvator* - MERTENS (in part). Senck. biol., 40(5/6):235. ("Obi").

1963 *Varanus salvator salvator* - MERTENS (in part). Das Tierreich, 79:16. ("Obi").

2010 *Varanus salvator ziegleri* KOCH & BÖHME, Russ. J. Herpetol., 17(4):301. – Type locality: Kali Telaga, Obi Island, Maluku Province, Indonesia.

**Type specimens.**—Holotype SMF 56442.

**Distribution.**—Probably restricted to the type locality and smaller islands nearby.

**Comments.**—The taxonomic distinctness of the Obi population has only recently been re-investigated (Koch and Böhme 2010), although the first record from that Moluccan island was published more than 50 y ago (Mertens 1959).

**Conservation status.**—For an assessment of this subspecies, see the general comments about *V. salvator*. Extensive mangrove forests still remain on



Obi Island, a major habitat used by *V. salvator ziegleri* (Weijola 2010). There is no information available on potential threats this population may be exposed to.

***Varanus togianus* (PETERS, 1872)** (Figs. 62, 63)  
1872 *Monitor (Hydrosaurus) togianus* PETERS, Monatb. Kön. Preuss. Akad. Wiss., 1872:582. – Type locality: Timotto, Togian (= Togeian) Islands, Central Sulawesi, Indonesia.  
1942 *Varanus (Varanus) salvator togianus* - MERTENS, Abh. Senckb. Naturf. Ges., 466:253.  
1997 *Varanus (Sotosaurus) salvator togianus* - ZIEGLER & BÖHME, Mertensiella, 8:177.  
2007 *Varanus togianus* - KOCH, AULIYA, SCHMITZ, KUCH & BÖHME, Mertensiella, 16:156.

**Type specimens.**—Lectotype ZMB 7388, paralectotype ZMB 7389 by designation of Mertens (1942).

**Distribution.**—Togian Islands and Sulawesi, except for the northern peninsula.

**Comments.**—Recent investigations revealed the endemic Sulawesi taxon *togianus* to be specifically distinct from *V. salvator* (Figs. 56–59) and polytypic (Koch et al. 2007; André Koch et al. unpubl. data).

**Conservation status.**—For a general assessment of the species' conservation status see the comments for *V. salvator* (Table 3). On Sulawesi, water monitors fall frequently victim to local traffic (Fig. 64) and are killed for human consumption or as a food competitor that may feed on poultry (André Koch, pers. obs.). However, because *Varanus togianus* have a wider distribution range than formerly assumed (Böhme 2003), the population status of *V. togianus* will likely remain stable over time. Nonetheless, *V. togianus* sensu strictu is restricted to the Togian Islands (André Koch et al., unpubl. data) and may therefore more likely be detrimentally affected by human activities.

### Subgenus *incertae sedis*

**Comments.**—*Varanus spinulosus* was traditionally assigned to the subgenus *Euprepiosaurus* but new morphological investigations revealed that this monitor lizard species probably belongs to a new monotypic subgenus (Böhme and Ziegler 2007, Yannick Bucklitsch et al., unpubl. data).

***Varanus spinulosus* MERTENS, 1941** (Figs. 65, 66)  
1941 *Varanus indicus spinulosus* MERTENS, Senckenbergiana, 23:269. – Type locality: “Georgs-Insel” (= St. George Island = San Jorge Island), near Santa Isabel (= Ysabel) Island, Solomon Islands.  
1942 *Varanus (Varanus) indicus spinulosus* - MERTENS, Abh. Senckb. Naturf. Ges., 466:271.

1994 *Varanus spinulosus* - SPRACKLAND, Herpetofauna, 24(2):34.

1997 *Varanus (Euprepiosaurus) spinulosus* - ZIEGLER & BÖHME, Mertensiella, 8:14.

2007 *Varanus* (subgen. inc. sed.) *spinulosus* - BÖHME & ZIEGLER, Mertensiella, 16:105.

**Type specimen.**—Holotype NMW 23387 (formerly NMW 3709).

**Distribution.**—San Jorge and Santa Isabel Islands, Solomon Islands, and Bougainville Island, Papua New Guinea.

**Comments.**—For nearly 50 years, this rare monitor lizard species was only known from the holotype specimen (Sprackland 1993b). The old collection number NMW 3709 of the holotype was given by Mertens (1941, 1942) and still much later by De Lisle (2009; see Tiedemann et al. 1994; Böhme and Koch 2010). Sprackland (1994) elevated the taxon *spinulosus* to full species status. Only recently, *V. spinulosus* was recorded with certainty from the islands of Santa Isabel and Bougainville (Böhme and Ziegler 2007; Dwyer 2008).

**Conservation status.**—*Varanus spinulosus* has not been assessed in the IUCN Red List. It is listed in CITES Appendix II. From 2008–2010 importing countries documented 83 wild-captured *V. spinulosus* specimens originating from the Solomon Islands (UNEP-WCMC. CITES Trade Database. 2012. *op.cit.*). For potential issues regarding the conservation status compare with *V. juxtindicus* and *V. indicus*.

## DISCUSSION AND CONCLUSIONS

**The Indo-Australian Archipelago: a center of monitor lizard diversity and endemism.**—Currently, 43 different species of monitor lizards with eight subspecies are known from the Indo-Australian Archipelago (plus *V. keithhornei* from Northern Australia). They are distributed over seven subgenera: *Varanus*, *Empagusia*, *Euprepiosaurus*, *Odatia*, *Papusaorus*, *Philippinosaurus*, and *Sotosaurus*. One species, viz. *V. spinulosus* (Fig. 65) from the Solomon Islands, is of uncertain subgeneric affiliation. Thus, recognized species diversity has increased by more than 300% since Mertens' (1959) checklist of the region was published 50 y ago. At that time, he distinguished only 13 species with a total of 20 subspecies (plus *V. griseus* from Northern Africa and Southern Asia). This high percentage of new species is not only caused by the discovery of novel species (e.g., *V. melinus*, see Fig. 27, and *V. mabitang*, see Fig. 46, from the Moluccas and the Philippines, respectively) but is also the result of taxonomic changes in various monitor lizard populations formerly

recognized as subspecies within wide-ranging polytypic species, which have since been (re-)elevated to full species status (e.g., the New Guinean members of the *V. prasinus* species group and the Philippine members of the *V. salvator* complex). In addition, detailed morphological and/or molecular investigations resulted in new descriptions through the taxonomic splitting of long recognized monitor lizard species (e.g., *V. bitatawa* and *V. palawanensis* which were split off from *V. olivaceus* and *V. marmoratus*, respectively), or the identification of morphologically cryptic species (e.g., *V. juxtindicus*, see Fig. 23, and *V. lirungensis*, see Fig. 25, which were formerly treated as *V. indicus*, Figs. 11, 12).

As Mertens (1959) recognized, diversity at the subgenus level is much higher on the islands of the Indo-Australian Archipelago than on the Australian continent (although the subgeneric classification of varanids has changed since Mertens' [1959] contribution), where only representatives of three subgenera (viz., *Varanus*, *Odatria*, and *Euprepiosaurus*) are found. The four subgenera *Empagusia*, *Papusauros*, *Philippinosaurus*, and *Soterosaurus* are endemic to Southeast Asia and the Indo-Australian islands, while none of the three Australian subgenera is entirely restricted to the continent. The only two remnants of the subgenus *Varanus* (i.e., *V. komodoensis* and *V. panoptes*), that are found today on Indo-Australian islands represent descendants of the successful Australian radiation of this subgenus. This also applies to *V. timorensis* (Fig. 41) and its allies of the subgenus *Odatria*, which account for more than two-thirds of Australia's monitor lizard diversity. *Varanus salvadorii* (Fig. 44), the only representative of the endemic New Guinean subgenus *Papusauros* (Mertens, 1962), is the closest extant relative of *V. komodoensis* (Fig. 2) and the Australian *V. varius* (Ast 2001; Fitch et al. 2006). These three giant lizard species form the basal group of the Australian radiations of the *V. gouldii* group and the dwarf monitor lizards (genus *Odatria*).

For the widespread Southeast Asian *V. salvator* complex, the subgenus *Soterosaurus* was erected (Ziegler and Böhme 1997). Its growing species numbers further enhance the diversity of Indo-Australian monitor lizards (Koch et al. 2010b). While traditionally considered monotypic (see Mertens 1942, 1959; Böhme 2003), this subgenus currently comprises more than 15% of Indo-Australian monitor lizards. At the same time, *Soterosaurus* is the only strictly Indo-Australian subgenus, where subspecies are still distinguished (Koch and Böhme 2010). Except for the morphologically well differentiated Philippine members of this closely related group (Koch et al. 2007), the remaining (island) populations of Southeast Asian water monitors reveal little differences in color pattern, scalation, and morphometrics. This is,

however, not true for those populations endemic to the Sulawesi region (i.e., Sulawesi and adjacent islands) and the Lesser Sunda Islands, where a remarkable diversity of locally endemic yet undescribed taxa with different color patterns evolved (André Koch et al. unpubl. data). This observation indicates that a relatively young radiation is involved and speciation is not yet completed in most populations.

*Philippinosaurus*, endemic to the Philippines, is an unusual subgenus that contains the only vegetarian varanids. Of these, *V. olivaceus* (Fig. 47) is the sister taxon of *Euprepiosaurus* (Ast 2001). *Varanus mabitang* (Fig. 45) has not yet been included in phylogenetic studies. With 22 recognized species, the heterogeneous *Euprepiosaurus* represents the most species-rich subgenus of varanids and, with 50% of the overall species diversity in the area, comprises the largest portion of Indo-Australian varanids. It embraces the arboreal tree monitor lizards around *V. prasinus* and the semi-aquatic Pacific or mangrove monitor lizards around *V. indicus*. Both groups show a high degree of local endemism on New Guinean satellite islands (e.g., *V. beccarii* and *V. macraei*) and in the northern Moluccas of Central Indonesia (e.g., *V. caerulivirens*, *V. zugorum* and *V. yuwonoi*), respectively (Ziegler et al. 2007a).

Biogeographically, New Guinea with its offshore islands is the most species-rich area in the Indo-Australian Archipelago, with 15 recognized monitor lizard species of four subgenera (see Table 4). On New Guinea itself, the world's second largest island, no fewer than eight different species are found (Fig. 1), two of which (i.e., *V. prasinus* and *V. salvadorii* as well as the subspecies *V. panoptes horni*) are endemics (Philipp and Philipp 2007). The occurrence of *V. cerambonensis* on New Guinea needs verification (Ziegler et al. 2007a). The satellite islands together harbor another eight endemic species. Each offshore island alone, like for instance Waigeo, is inhabited by no more than four different monitor species. The Moluccas are second in monitor lizard species richness after New Guinea. Altogether, nine species are distinguished allocated to the subgenera *Euprepiosaurus* and *Soterosaurus* (Table 4). Sympatry between both these ecologically similar monitor lizard groups was long considered impossible (Ziegler et al. 2007a) and could only recently be confirmed (Weijola 2010). The taxonomic status of recently encountered populations of *V. salvator* in the Moluccas requires further investigations (Koch and Böhme 2010). The *V. indicus* species group of the subgenus *Euprepiosaurus* experienced a successful radiation in the northern Moluccas and provides 90% of the species diversity. Up to four different members of *Euprepiosaurus* can be found on the island of Halmahera alone (Fig. 1, Table 4). At least six species (*V. caerulivirens*, *V. melinus*, *V. obor*, *V.*

# Koch et al. 2012.—Conservation Status of Monitor Lizards.

**TABLE 4.** Geographic distribution of Southeast Asian and Indo-Australian monitor lizard species (*Varanus* spp.) sorted by countries and main islands in the region as shown in Fig. 1. For northern Australia only those species are listed which also inhabit the Indo-Australian Archipelago. Numbers of monitor lizard species and subgenera, respectively, occurring in each nation or island (group) are given in parentheses. Counts include only confirmed records. Species records followed by a question mark deserve validation. An “E” in parentheses after the (sub)species name demarks an endemic taxon restricted in its distribution range to a single island (group). Uncertain taxonomic status of a population is indicated by “cf.” or “ssp.”.

REGION	MONITOR LIZARD TAXA
<b>Mainland Southeast Asia (6/2):</b>	
India, Bangladesh, Myanmar (Burma) (3/2):	<i>salvator macromaculatus</i> , <i>bengalensis</i> , <i>flavescens</i> , (plus <i>griseus</i> for India)
Sri Lanka (2/2):	<i>s. salvator</i> (E), <i>bengalensis</i>
Cambodia, Laos, Vietnam (2/2):	<i>nebulosus</i> , <i>salvator macromaculatus</i>
Thailand, Malaysia (4/2):	<i>dumerilii</i> , <i>nebulosus</i> , <i>rudicollis</i> , <i>salvator macromaculatus</i>
<b>Greater Sunda Islands (4/2):</b>	
Sumatra (4/2):	<i>nebulosus</i> , <i>dumerilii</i> , <i>rudicollis</i> , <i>salvator macromaculatus</i>
Borneo (3/2):	<i>dumerilii</i> , <i>rudicollis</i> , <i>salvator macromaculatus</i>
Java (2/2):	<i>salvator bivittatus</i> , <i>nebulosus</i>
<b>Philippines (8/2):</b>	
Palawan (1/1):	<i>palawanensis</i> (E)
Mindoro (1/1):	cf. <i>marmoratus</i>
Mindanao (1/1):	<i>c. cumingi</i> (E)
Luzon (3/2):	<i>bitatawa</i> (E), <i>olivaceus</i> (E), <i>marmoratus</i> (E)
Samar, Leyte, Bohol (1/1):	<i>cumingi samarensis</i> (E)
Panay (2/2):	<i>mabintang</i> (E), <i>nuchalis</i>
Cebu, Negros, Masbate (1/1):	<i>nuchalis</i>
Sulu Islands (1/1):	<i>rasmusseni</i> (E)
<b>Sulawesi region (3/2):</b>	
Sulawesi and adjacent islands (2/1):	<i>salvator</i> ssp. (E), <i>togianus</i> ssp. (E)
Togean Islands (1/1):	<i>togianus</i> (E)
Banggai Islands (1/1):	<i>salvator</i> ssp. (E)
Flores Sea Islands (1/1):	<i>salvator</i> ssp. (E)
Talaud Islands (1/1):	<i>lirungensis</i> (E)
<b>Lesser Sunda Islands (4/3):</b>	
Bali, Lombok, Sumbawa, Sumba (1/1):	<i>salvator bivittatus</i>
Flores (2/2):	<i>salvator bivittatus</i> , <i>komodoensis</i> (E)
Timor and offshore islands (2/1):	<i>timorensis</i> (E), <i>auffenbergi</i> (E), <i>indicus</i> (?)
<b>Moluccas (9/2):</b>	
Halmahera and smaller offshore islands (4/1):	<i>caerulivirens</i> , <i>yuwonoi</i> (E), <i>zugorum</i> (E), <i>rainerguentheri</i> , <i>indicus</i> (?), <i>salvator</i> ssp. (?)
Sula Islands (3/2):	<i>melinus</i> (E), <i>salvator</i> ssp. (E), <i>obor</i> (E)
Obi (3/2):	<i>caerulivirens</i> , <i>rainerguentheri</i> , <i>salvator zieglerei</i> (E), <i>indicus</i> (?), <i>yuwonoi</i> (?)
Ceram, Ambon, and Buru (2/1):	<i>cerambonensis</i> , <i>indicus</i>
Tanimbar (Timorlaut) (1/1):	cf. <i>indicus</i>
<b>New Guinea and offshore islands (15/4):</b>	
New Guinea (8/4):	<i>doreanus</i> , <i>finschi</i> , <i>indicus</i> , <i>jobiensis</i> , <i>prasinus</i> (E), <i>panoptes horni</i> (E), <i>salvadorii</i> (E), <i>similis</i> , <i>cerambonensis</i> (?)
Aru Islands (3/1):	<i>beccarii</i> (E), <i>doreanus</i> , <i>indicus</i>
Kai Islands (2/1):	cf. <i>finschi</i> (E), <i>indicus</i>
Biak (4/1):	<i>kordensis</i> (E), <i>doreanus</i> , <i>jobiensis</i> , <i>indicus</i>
Yapen (2/1):	<i>indicus</i> , <i>jobiensis</i> , <i>kordensis</i> (?)
Batanta (2/1):	<i>macraei</i> (E), <i>indicus</i>
Miso(o)l (2/1):	<i>reisingeri</i> (E), <i>indicus</i>
Waigeo (4/1):	<i>boehmei</i> (E), <i>jobiensis</i> , <i>indicus</i> , <i>doreanus</i>
Salawati (4/1):	<i>prasinus</i> , <i>doreanus</i> , <i>jobiensis</i> , <i>indicus</i>
D'Entrecasteaux Islands (2/1):	<i>bogerti</i> (E), <i>indicus</i>
Louisiade Archipelago (3/1):	<i>bogerti</i> (E), <i>indicus</i> , <i>telenesetes</i> (E)
Trobriand Islands (2/1):	cf. <i>indicus</i> , <i>jobiensis</i> (new record)
<b>Pacific island groups (4/2):</b>	
Admiralty Islands (2/1):	<i>indicus</i> , cf. <i>finschi</i>
Bismarck Archipelago (2/1):	<i>indicus</i> , <i>finschi</i>
Solomon Islands (3/2):	<i>juxtindicus</i> (E), <i>indicus</i> , <i>spinulosus</i> (E)
Mariana, Marshal and Palau islands (1/1):	cf. <i>indicus</i>
<b>Australia (5/2):</b>	
Queensland (5/2):	<i>keithhornei</i> (E), <i>indicus</i> , <i>doreanus</i> , <i>finschi</i> , <i>similis</i>



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*rainerguentheri*, *V. yuwonoi*, *V. zugorum*) of this group are endemic to the Moluccan islands (see Table 4).

Another important biogeographical subregion of the Indo-Australian Archipelago is in the Philippines. Here, no more than three different monitor lizard species are found on a single island (see Table 4). In total, however, at least eight species distributed over the subgenera *Philippinosaurus* and *Sotosaurus* occur on the Philippines. The latter subgenus constitutes nearly two-thirds of this diversity and several smaller islands may harbor further undescribed taxa. All Philippine monitor species are endemics to single or only few islands that formerly formed emerged island complexes during lowered sea levels in the Pleistocene (Koch et al. 2010b).

Compared to these species-rich areas of the Indo-Australian Archipelago, the remote Pacific Island groups of the Bismarck, Solomon, or Palau Islands are known to harbor only four different monitor lizard species, which either belong to the widespread species group around *V. indicus* or probably constitute a new subgenus of *Varanus* (i.e., *V. spinulosus*, Fig. 65). This latter species and *V. juxtindicus* are endemic to the Solomon Islands but the distribution ranges and species composition on several oceanic archipelagos in the Pacific is not yet fully understood.

In sum, the countless islands of the Indo-Australian Archipelago harbor more than half of the global monitor lizard diversity. With inclusion of *V. bengalensis* and *V. flavescens* (Fig. 8), the only strictly mainland Southeast Asian monitor species, this quota reaches 60%. In contrast, Australia, which is the second largest hotspot of varanid diversity on the earth, is home to 29 different monitor species (about 40% of global species diversity), five of which (*V. indicus*, *V. finschi*, *V. doreanus*, *V. similis*, and *V. panoptes*) are shared with the Indo-Australian Archipelago. By comparison, the African continent has only six monitor species (< 10% of overall varanid diversity) distributed over the two subgenera *Polydaedalus* and *Psammosaurus*. Despite increased taxonomic investigations and numerous species descriptions in recent years, further discoveries of novel monitor lizard taxa from the islands of the Indo-Australian Archipelago are to be expected in the future, hence, further enhancing the importance of this vast island region as global hotspot of varanid diversity and endemism.

**Identification key for Southeast Asian and Indo-Australian monitor lizards: necessity and proposed utility.**—There is a clear need for an actualized key for the identification of Southeast Asian and Indo-Australian monitor lizard species (see Appendix II). Recent publications on monitor lizards, for instance by Bennett (1998), Böhme (2003) and Pianka et al. (2004), provided a taxonomic overview with general

biological data, but are of limited use for the identification of the various monitor lizard species of Southeast Asia and the Indo-Australian Archipelago. De Rooij (1915:141–142), Mertens (1942:242ff., 1959:222–224) and Brandenburg (1983:7) provided the latest identification keys of these monitor lizards. The latter, most recent one, however, was never published and comprised only 10 Indonesian species. Thus, these keys are long outdated. Recently, Ziegler et al. (2007a) published a key for the subgenus *Euprepiosaurus*, which, among others, did not include the newly described *V. lirungensis* and *V. obor* from Indonesia and, thus, covered only half of the monitor lizard diversity of Southeast Asia and Indo-Australia.

Globally, monitor lizards and their products are important goods in the world-spanning trade with live pets and reptile leather. Consequently, all members of the genus *Varanus* are protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The insufficient knowledge of customs employees and wildlife guards may additionally contribute to uncontrolled exploitation of endemic island populations with restricted distribution ranges. The possibility that officials lack sufficient expertise in identifying species is indirectly supported by the high number of new monitor lizard species that first showed up in Europe and the US by entering the trade under the name of common and widespread species (such as *V. indicus*). Therefore, the present key refers to external morphological characters to be of use for both scientists and untrained laypersons such as members of governmental organizations and international customs officers that control the global trade of live monitor lizards and their products.

**Pressing problems: threats and conservation status of Southeast Asian and Indo-Australian monitor lizards.**—In Indo-Australia tectonic and geological events have created the world's biggest archipelago with thousands of islands harboring various ecosystems and climate regimes. These conditions have led to adaptive speciation processes and radiations in many organism groups resulting in a megadiverse flora and fauna (Mittermeier et al. 2004; Baillie et al. 2010). At the same time, global deforestation rate is considered highest in Southeast Asia and is identified as the major threat to tropical biodiversity in most Southeast Asian countries including the Philippines and Indonesia (Sodhi and Brook 2006). For instance, the alarming deforestation rate is a significant threat to various forest biotas in New Guinea commonly accompanied by the conversion of primary rain forest to agricultural land, in particular oil palm plantations (Frazier 2007). At present Indonesia's oil palm estates are estimated at 9.4 million ha and approximately 600,000 ha of forest are annually cleared for the purpose of expanding oil palm plantations. Papua New Guinea's plantations

cover approximately 500,000 ha, and another 5.6 million ha have been set aside for oil palm (Colchester et al. 2011).

These findings mirror the overall-extinction risk in amphibians, birds, and mammals, which again globally is highest in Southeast Asia (Hoffmann et al. 2010). A similar situation is evident in reptiles (Böhm et al. 2012). Current threats opposed to the monitor lizards of Southeast Asia and the Indo-Australian realm are numerous, but vary across the different *Varanus* species. Those species in which extinction risk is most likely to occur first are arboreal species endemic to small islands and associated with pristine rain forest habitats such as *V. beccarii* (Fig. 35), *macraei* (Fig. 39) and *V. reisingeri* (Fig. 40). The destruction of these biological diverse ecosystems (e.g., in the Philippines), has already led to severe population declines in *V. mabitang* (Fig. 45) and *V. olivaceus* (Fig. 47; Gaulke et al. 2007b; International Union for Conservation of Nature, The IUCN Red List of Threatened Species, Version 2010.4. Sy, E., L. Afuang, M.R. Duya, and M. Diesmos. 2007. *Varanus olivaceus*. Available from <http://www.iucnredlist.org/apps/redlist/details/22888/0> [Accessed 12 January 2011]). Overall, < 20% of the Philippines' primary forests remain today and recent studies predicted that Philippine primary forests will be cleared by the next decade (Suarez and Sajise 2010).

Another constant threat to wildlife is the legal and illegal trade for varying purposes (Chivian and Bernstein 2008). Southeast Asia is considered one of the major regions for the harvest and trade in global wildlife (Sodhi et al. 2004; Deeks 2006; Nijman et al. 2012). There has been a general consensus among experts that highly valued Southeast Asian wildlife involved in the commercial trade has distinctly declined over the last ten years (TRAFFIC 2008). These hard facts corroborate that any regulatory measures in place, such as harvest quotas or protection



**FIGURE 67.** Dead *Varanus kordensis*, *V. macraei*, *V. reisingeri*, and *V. beccarii* (from front to back) next to some dead specimens of *Morelia viridis* at the wildlife rescue station in Munich, Germany. These New Guinean tree monitor lizards and pythons are focal species of the international pet market. Thousands of specimens perish before they even enter the trade. (Photographed by Mark Auliya).

status, fail to sustainably secure viable populations of those species in international demand. The magnitude of the reptile trade (legal and illegal) in this region is highlighted in various studies (Jenkins and Broad 1994; van Dijk et al. 2000; Engler and Parry-Jones 2007; Nijman et al. 2012).

The access into formerly remote forested regions, initiated through logging activities and the establishment of a basic infrastructure, is used to meet western demands for the international pet industry. Monitor lizards are among the most sought-after reptile groups in the global pet trade and the increasing impact this trade may cause in certain varanid species is of international concern (Weissgold 2000; Pernetta 2009). This potentially unsustainable exploitation is triggered by: (1) the morphological distinctiveness (e.g., impressive body size in concert with striking colors and patterns) varanids display; (2) the unique behavioral ecology and intelligence of these lizards; and (3) their rarity value in conjunction with national and international protection statuses, resulting in high



**FIGURE 68.** *Varanus jobiensis* (head visible), *V. salvadorii* (head not visible), and *V. doreanus* (only tail visible) at a local reptile collector in Sorong. Note the disastrous conditions under which these monitors are kept for the pet trade. (Photographed by Mark Auliya).



**FIGURE 69.** Three subadult and adult specimens of *Varanus dumerilii* and one *V. rudicollis* (with light injuries on snout) at a trader in West Kalimantan, Borneo. (Photographed by Mark Auliya).

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economic values and demand.

Particularly smaller-sized species, such as representatives of both the *V. indicus* and *V. prasinus* species groups (Fig. 67), are highly in demand for the international pet trade (Leary 1991; Hoover 1998; Auliya 2003, 2009). Therefore, the conservation status of the following five monitor lizard species appears to be of severe concern with regard to their restricted distribution ranges on small Indonesian islands and their continuous annual take-off levels from the wild (see Table 3). These five species are *V. melinus* (Figs. 27, 28), *V. beccarii* (Fig. 35), *V. boehmei* (Fig. 36), *V. macraei* (Fig. 39), and *V. yuwonoi* (Fig. 32). Data on the population and conservation status of all these monitor lizard species is completely lacking as is the case for all other varanids of this review. Although international trade is well established, Indonesia has not allotted any official export quotas for these nationally unprotected species.

Likewise, Indonesia's nationally protected monitor lizard species, viz. *V. indicus* (Figs. 11, 12), *V. komodoensis* (Fig. 2), *V. nebulosus* (Figs. 4, 5), *V. panoptes horni* (listed as "*V. gouldii*"), *V. prasinus*, *V. timorensis*, and *V. togianus* (listed as *V. salvator togianus*), are not subject to an annual quota system. These are only permitted for export as F2-stock produced in a closed-cycle production system. Therefore, the result of "(...) captive breeding of protected wild animals, which can be traded, is the second generation and the subsequent generations (...)" (Decree of the Ministry of Forestry, No P.19-II/2005). According to the Indonesian legislation, the capture for export of several CITES and nationally non-protected *Varanus* spp. follows a quota system (see Table 2). "A quota (...) is established for wild plant and animal specimens of species listed or not listed in the CITES Appendices, whether protected or unprotected" (Decree of the Minister of Forestry Indonesia – Number: 447/Kpts-II/2003). All species



**FIGURE 70.** Dozens of decapitated specimens of *Varanus salvator macromaculatus* at a slaughterhouse in West Malaysia. (Photographed by Mark Auliya).



**FIGURE 71.** Thousands of Water Monitor Lizards (*Varanus salvator* spp.) are cruelly harvested and killed each year for their skins. (Photographed by Mark Auliya).



**FIGURE 72.** A seized reptile leather bag made of *Varanus salvator* skin. These luxurious fashion goods are mainly produced for consumers in the EU, Japan, and the USA. (Photographed by Mark Auliya).



not listed in Table 2 have not been allocated an annual harvest and export quota, respectively. For those species, the Decree of the Minister of Forestry Indonesia – Number: 447/Kpts-II/2003 further states, that the “harvest or capture of wild plants and animals whose species is not in the established quota may be permitted for the purpose of study, research and development, only if the Scientific Authority is satisfied that such harvest or capture will not be detrimental to the wild population.”

However, to date it is clear that annual quotas, which have been set for merely seven Indonesian monitor lizard species, are not based on any field studies to assess population densities and harvest impact current trade levels may indicate. Article IV of the CITES regulations requires, that “exporting countries restrict trade in Appendix II species to levels that are not detrimental either to the species survival, or to their role within their ecosystems in which they occur (known as the non-detriment finding)” (Rosser and Haywood 2002). Despite this official requirement, harvest in all Indo-Australian monitor lizard species is not regulated; there is no sound science-based socio-economic model in place to create adaptive management plans based on certain sustainability indices. One species, *V. salvadorii* (Fig. 44), has been allotted an annual export quota (Table 2) and is involved in the global reptile trade (Horn 1995; WWF Irian Jaya 1999). Wild-captured specimens, however, are prohibited to enter the European Union (see Table 5). The implementation and enforcement of relevant laws addressing the harvest of, for instance, *V. salvadorii* in remote regions such as West Papua, is a considerable issue.

Additionally, not all captured specimens survive captive conditions and treatment prior to shipping to national exporters’ premises on Java. According to data compiled by the Forestry Office of Papua Province in 1998, the number of captured unprotected reptiles in 1998–1999 was 33,925, while the number of those actually “transported,” i.e., traded, was only 11,682 specimens, thus equaling only 35% of the original amount captured (Marshall and Beehler 2007). This implies that most reptile specimens gathered for the international pet market actually die before they enter the trade. Reasons as commonly observed are disastrous handling and unhygienic conditions at local collectors and traders (Figs. 68, 69). In addition, high transport mortality rates along the trade chain from the source country to the final destinations in Europe, Japan or the USA are very likely (Leader-Williams 2002).

Only few large-growing monitor species, particularly *V. salvator* (Table 3), are commercially harvested for their skins (Figs. 70, 71) to produce various fashion goods (Fig. 72) mainly for demands in the western industrial nations of Europe and North America (Luxmoore and Groombridge 1990; Shine et al. 1996, 1998; Riquier 1998, Auliya 2006). Newer

studies indicate the detrimental impact the skin trade has on local monitor populations, while some populations have even been locally extirpated due to the enormous annual harvest levels for the international reptile leather industry occurring over the last decades (Auffenberg 1994; Shine et al. 1996; Auliya 2006). As outlined above in the species account, a more comprehensive analysis of current threats and the conservation status of single Indo-Australian *Varanus* species in view of current implemented national and international legislation is in preparation (Mark Auliya et al., unpubl. data).

It is evident that the international pet trade in monitor lizards originating from Southeast Asia and the Indo-Australian Archipelago impacts a much higher number of species compared to those involved in the commercial skin trade (Table 2; see also Hoover 1998; Auliya 2003; Kanari and Auliya 2011). Trade impact in live *Varanus* species still remains poorly understood, given the fact that field conservation studies are almost completely lacking, particularly in the tropics (Weissgold 2000; see also assessment of *V. melinus*). Current Indonesian legislation appears non-transparent and incomplete to conserve Indonesia’s currently recognized 28 monitor lizard species. One major reason is that traders, particularly those harvesting species, next to collectors and middlemen, react highly responsive to lucrative opportunities which are generated by international demand (TRAFFIC 2008). Traders have largely benefited from the paucity of information available from the wild. In addition, the complex geography of this vast island region together with the taxonomic uncertainty in look-a-like species and the lack of capacity building programs, training material and guides in the countries of origin hamper an efficient trade control. The international community needs more efficient conservation strategies to considerably reduce current levels of (over-)exploitation and extinction risks in the wild, particularly of the above mentioned focal species. Therefore, we strongly advocate the establishment of an IUCN/SSC Monitor Specialist Group to improve monitoring of threats and population trends of *Varanus* spp. native to Southeast Asia and the Indo-Australian realm.

This group of international experts could contribute to the long-term survival of monitor lizards by providing technical assistance, training, and, eventually, the establishment of species-specific management programs. Within such a program, a particular goal should be to elaborate the non-detriment finding approach for *Varanus* spp. as a simple and easy-to-use tool (Rosser 2002), to ideally establish sustainability indices, such as population size, age at maturity, and reproductive frequency with certainty. Scott and Seigel (1992) already outlined several concepts of managing reptile populations under harvest pressure. At its best, the ultimate method will incorporate other threats than trade to

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identify sustainable take-off levels and evaluate the economic feasibility in the captive propagation and management of selected *Varanus* spp. (Werner 1991). Moreover, the long-term conservation of Southeast Asian and Indo-Australian monitor lizard diversity may also imply the need to temporarily suspend trade in threatened species and in such with a high extinction risk in the wild. Hopefully soon IUCN Red List Assessments will be available, guiding both consuming and source countries in order to maintain viable populations of *Varanus* spp. in the long-term.

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**ANDRÉ KOCH** is a postdoc at the Zoologisches Forschungsmuseum Alexander Koenig in Bonn, Germany, where he already received his diploma. Since he started his scientific career, André has been involved in taxonomic, systematic and biogeographic research projects about Southeast Asian and Indo-Australian monitor lizards. During field work in Indonesia and collection-based investigations, André and his collaborators have documented the neglected and underestimated diversity of these CITES-relevant giant reptiles. Based on his discoveries, several new monitor lizard species and subspecies have been described from Indonesia and the Philippines in recent years. In addition, André is interested in the herpetofaunal diversity of Indonesia with a special focus on Sulawesi and adjacent islands. (Photographed by Evy Arida).



**THOMAS ZIEGLER** commenced with monitor lizard research in the framework of his thesis in 1994. Since 2003 he has been the Curator of the Aquarium/Terrarium Department of the Cologne Zoo and Coordinator of the Biodiversity and Nature Conservation Projects in Vietnam. Since 1994, Thomas has published 245 papers and books. Of these, 55 deal with systematics and diversity of monitor lizards. Since February 2009, he is an Associate Professor at the Zoological Institute of Cologne University. (Photographed by Claus Baetke)



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**WOLFGANG BÖHME** was for nearly 40 years the Curator of Herpetology at the Zoologisches Forschungsmuseum Alexander Koenig in Bonn, Germany, and has continued research and teaching after his retirement in November 2010 on a voluntary basis. He supervised 130 theses of Master's students and 39 theses of Doctoral candidates, among the latter the three coauthors of the present paper. His published record comprises to date more than 600 articles, book chapters, and books. He has worked on taxonomy, systematics, and phylogeny of monitor lizards since the 1980s and published numerous articles on this group, to a great extent together with his Ph.D. students. He (co-)authored 15 new species-group taxa and one new genus-group taxon of monitor lizards. (Photograph from the ZFMK Archive).

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**APPENDIX I.** List of all valid monitor lizard species and subspecies from Southeast Asia and the Indo-Australian Archipelago recognized in this review.

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**Genus *Varanus* MERREM, 1820 (44 spp., 7 ssp.)**

**Subgenus *Varanus* MERREM, 1820 (2 spp.)**

*Varanus komodoensis* OUWENS, 1912

*Varanus panoptes horni* BÖHME, 1988

**Subgenus *Empagusia* GRAY, 1838 (5 spp.)**

***Varanus bengalensis* species group (2 spp.)**

*Varanus bengalensis* (DAUDIN, 1802)

*Varanus nebulosus* (GRAY, 1831)

*Varanus dumerilii* (SCHLEGEL, 1844)

*Varanus flavescens* (HARDWICKE & GRAY, 1827)

*Varanus rudicollis* (GRAY, 1845)

**Subgenus *Euprepiosaurus* FITZINGER, 1843 (22 spp.)**

***Varanus indicus* species group (13 spp.)**

*Varanus indicus* (DAUDIN, 1802)

*Varanus caerulivirens* ZIEGLER, BÖHME & PHILIPP, 1999

*Varanus cerambonensis* PHILIPP, BÖHME & ZIEGLER, 1999

*Varanus doreanus* (A. B. MEYER, 1874)

*Varanus finschi* BÖHME, HORN & ZIEGLER, 1994

*Varanus jobiensis* AHL, 1932

*Varanus juxtindicus* BÖHME, PHILIPP & ZIEGLER, 2002

*Varanus liruensis* KOCH, ARIDA, SCHMITZ, BÖHME & ZIEGLER, 2009

*Varanus melinus* BÖHME & ZIEGLER, 1997

*Varanus obor* WEIJOLA & SWEET, 2010

*Varanus rainierguentheri* ZIEGLER, BÖHME & SCHMITZ, 2007

*Varanus yuwonoi* HARVEY & BARKER, 1998

*Varanus zugorum* BÖHME & ZIEGLER, 2005

***Varanus prasinus* species group (9 spp.)**

*Varanus prasinus* (SCHLEGEL, 1844)

*Varanus beccarii* (DORIA, 1874)

*Varanus boehmei* JACOBS, 2003

*Varanus bogerti* MERTENS, 1950

*Varanus keithhornei* (WELLS & WELLINGTON, 1985)

*Varanus kordensis* (A. B. MEYER, 1874)

*Varanus macraei* BÖHME & JACOBS, 2001

*Varanus reisingeri* EIDENMÜLLER & WICKER, 2005

*Varanus telenesetes* SPRACKLAND, 1991

**Subgenus *Odatria* GRAY, 1838 (3 spp.)**

***Varanus timorensis* species group (3 spp.)**

*Varanus timorensis* (GRAY, 1831)

*Varanus auffenbergi* SPRACKLAND, 1999

*Varanus similis* MERTENS, 1958

**Subgenus *Papusaurus* MERTENS, 1962 (1 sp.)**

*Varanus salvadorii* (PETERS & DORIA, 1878)

**Subgenus *Philippinosaurus* MERTENS, 1959 (3 spp.)**

*Varanus bitatawa* WELTON, SILER, BENNETT, DIOSMOS, DUYA,

DUGAY, RICO, VAN WEERD & BROWN, 2010

*Varanus mabitang* GAULKE & CURIO, 2001

*Varanus olivaceus* HALLOWELL, 1856

**Subgenus *Sotosaurus* ZIEGLER & BÖHME, 1997 (7 spp., 7 ssp.)**

*Varanus cumingi* MARTIN, 1838

*Varanus c. cumingi* MARTIN, 1838

*Varanus cumingi samarensis* KOCH, GAULKE & BÖHME, 2010

*Varanus marmoratus* (WIEGMANN, 1834)

*Varanus nuchalis* (GÜNTHER, 1872)

*Varanus palawanensis* KOCH, GAULKE & BÖHME, 2010

*Varanus rasmusseni* KOCH, GAULKE & BÖHME, 2010

*Varanus salvator* (LAURENTI, 1768)

*Varanus s. salvator* (LAURENTI, 1768)

*Varanus salvator andamanensis* DERANIYAGALA, 1944

*Varanus salvator bivittatus* (KÜHL, 1820)

*Varanus salvator macromaculatus* DERANIYAGALA, 1944

*Varanus salvator ziegleri* KOCH & BÖHME, 2010

*Varanus togianus* (PETERS, 1872)

**Subgenus: *incertae sedis* (1 sp.)**

*Varanus spinulosus* MERTENS, 1941

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**APPENDIX II.** Identification key for the monitor lizards of Southeast Asia and the Indo-Australian Archipelago. The key mainly follows the structure by Mertens (1959) and Ziegler et al. (2007a). Idiosyncrasies were completed with data from Mertens (1942), Böhme (1988b), Sprackland (1999), Gaulke and Curio (2001), Böhme and Ziegler (2007), Koch et al. (2007), Koch et al. (2010b), and Welton et al. (2010).

**A. Key to single species, species groups and subgenera:**

1. Tail round in cross section; no distinct dorsal keel(s) present (Figs. 34, 41). Go to 2.
  - Tail laterally flattened; distinct dorsal keel(s) present (Fig. 22). Go to 3.
  - First third of tail roundish; tail lacking a differentiated double keel on the dorsal ridge (Fig. 24); brown dorsum with yellow spots (Fig. 23); throat light, unpatterned; temporal stripe absent; low midbody scale counts (128–140); tongue light, with an ill-defined dark pigmentation in the anterior most part; at least adult males with swollen parietal region. *Varanus juxtindicus*.
2. Tail not prehensile (Fig. 41). *Varanus timorensis* species group (I).
  - Tail prehensile (Fig. 34). *Varanus prasinus* species group (II).
3. Tail only slightly laterally flattened, but very long (250 to 260 percent of the snout vent length) (Fig. 44). *Varanus salvadorii*
  - Tail distinctly laterally flattened; tail length never reaches 200 percent of the snout vent length. Go to 4.
4. Nostril slit-like (Fig. 46). Go to 5.
  - Nostril round to oval (Figs. 18, 60). Go to 6.
5. Small midbody scales, resulting in a high number of scales around the midbody (175–212). **subgenus *Philippinosaurus* (IV).**
  - Large midbody scales, resulting in a low number of scales around the midbody (66–169). **subgenus *Empagusia* (V).**
6. Supraocular scales not enlarged (e.g. Fig. 3). Go to 7.
  - Supraocular scales enlarged (e.g. Fig. 61). Go to 8.
7. Large growing species (up to 3 m total length); snout broad, blunt; tail length equals snout vent length or slightly surpasses it; tail of adults without pattern (Fig. 2). *Varanus komodoensis*.
  - Medium sized species (up to 1.4 m total length); snout narrow, pointed; tail ca. 1.5 times snout vent length; tail tip always with light and dark transverse bands. *Varanus panoptes horni*.
8. Neck scales very small, spike-like (Fig. 66); the entire dorsal skin gives the impression of sandpaper when touched; high number of scales around the midbody (206–210). *Varanus spinulosus* (**subgenus *incertae sedis***).
  - Neck and dorsal scales not such small and spike-like; number of scales around the midbody usually below 200 (with the exception of *V. jobiensis* which has a maximum midbody scale count of 201). Go to 9.
9. Tongue always dark pigmented (Fig. 48), at least above; nostrils very close to snout tip (distance from nostril to eye at least twice the distance from nostril to snout tip); usually with bright and dark crossbands on the snout (Fig. 60); sometimes a light longitudinal stripe along the neck present; throat and belly often with dark pointed bars laterally (Fig. 64, see also specimen on author picture of André Koch). **subgenus *Sotosaurus* (VI).**
  - Tongue color variable (from entirely light [Fig. 13] to entirely dark [Fig. 11]); nostrils relatively distant from snout tip (distance from nostril to eye less than twice the distance from nostril to snout tip); usually without bright and dark crossbands on the snout (e.g. Figs. 16, 18); a light longitudinal stripe along the neck always absent; ventral side without dark pointed bars. *Varanus indicus* species group (III).

**B. Keys to the species and subspecies of species groups and subgenera:**

**I. *Varanus timorensis* species group of subgenus *Odatria*:**

1. Lateral postcloacal scales spine-like enlarged (in particular in males). *Varanus similis*.
  - Lateral postcloacal scales not enlarged. Go to 2.
2. Dorsal pattern consisting of cream ocelli (Fig. 41); upper surface of head with black background; mottled cream-colored belly. *Varanus timorensis*.
  - Dorsal pattern consisting of pale blue-grey ocelli (Fig. 42), upper surface of head with dull orange background; unmarked cream-colored belly; restricted to Roti Island. *Varanus auffenbergi*.

**II. *Varanus prasinus* species group of subgenus *Euprepiosaurus*:**

1. Body melanistic, unpatterned (Fig. 35). Go to 2.
  - Body not melanistic, only dorsal ground coloration black, with distinct light pattern. Go to 3.
  - Dorsal ground coloration of body greenish-yellow, green or bluish-green. Go to 5.
2. Tubercular, sharply keeled nuchals; rugose cranial scales; smooth ventrals; number of scales around the midbody higher than 95. *Varanus bogerti*.
  - Triangular keeled, hull-shaped nuchal scales; cranials not as rugose as in *V. bogerti*; slightly keeled ventrals; number of midbody scales lower than 86. *Varanus beccarii*.
3. Dorsal pattern consisting of transversal rows of blue ocelli (Fig. 39); tail with alternating blue and black bands; neck scales smooth, unkeeled; restricted to Batanta Island. *Varanus macraei*.
  - Dorsal pattern consisting of golden or yellow speckles that form chevrons; tail with yellow spots or alternating yellow and black bands; neck scales granular to slightly keeled. Go to 4.
4. Golden dorsal speckles arranged in chevrons (Fig. 36); snout tip light yellow; gular scales round to oval; 67–79 transverse rows of ventral scales (from gular fold to beginning of hind legs). *Varanus boehmei*.
  - Yellow dorsal spots, forming thin, paired chevrons (Fig. 37); snout blue-grey in color; gular scales conical, pointed; 84–91 transverse rows of ventral scales (from gular fold to beginning of hind legs). *Varanus keithhornei*.
5. Dorsal ground coloration yellow or greenish-yellow with transversal dark bands or a dark reticulation (Fig. 40); throat greenish-yellow; restricted to Misool Island. *Varanus reisingeri*.
  - Dorsal ground coloration green or bluish-green. Go to 6.
6. Dorsum olive to bluish-green with dark ocelli or black reticulation (Fig. 38); nuchal scales strongly keeled. *Varanus kordensis*.
  - Dorsum bright green with V-shaped stripes; nuchals smooth or slightly keeled. Go to 7.
7. Ventral side green (Fig. 34); throat light, patternless; palms black; 72–88 transverse rows of slightly keeled ventral scales (from gular fold to beginning of hind legs). *Varanus prasinus*.
  - Ventral side mottled; throat banded; palms pale; 92 transverse rows of smooth ventral scales (from gular fold to beginning of hind legs). *Varanus telenesetes*.

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### III. *Varanus indicus* species group except *V. juxtindicus* of subgenus *Euprepiosaurus*:

1. Tongue entirely dark (Fig. 11); dorsum dark brownish-black, with small whitish-yellow spots, mostly smaller than an area covered by five scales; lack of blue pigmentation, even on the tail of juveniles; light, unpatterned throat; absence of a light, dark-bordered postocular/supratemporal stripe; very low midbody scale counts (106–137). *Varanus indicus*.
  - Tongue dark pigmented dorsally, with light tines (Fig. 32). Go to 2.
  - Tongue dark bluish or greyish pigmented anteriorly, becoming distinctly lighter laterally and posteriorly. Go to 3.
  - Tongue entirely light, pinkish (Fig. 13). Go to 4.
2. Tongue dark violet, with light tines; anterior one-third to one-half of the dorsum blackish and with few wide bands, the caudal half of the body finely speckled with yellowish green, blue, and black (Fig. 32); large black blotches on the sides of the neck; light throat, with indistinct dark marbling; dark temporal stripe; tail with blue color; high midbody scale counts (174–188). *Varanus yuwonoi*.
  - Tongue of adults only dorsally pigmented dark grey, flesh-colored at base and ventrally; dorsal background color black, irregularly scattered with numerous yellow scales that form indistinct blotches or short transverse lines consisting of 3–8 scales on the dorsum (Fig. 25); 135–151 scales around midbody. *Varanus lirungensis*.
3. Dorsum uniformly grey to greenish-olive, without distinct pattern (Fig. 33); very slender habitus, with a particular elongated neck; temporal streak lacking. *Varanus zugorum*.
  - Dorsum grey with transversal rows of ocelli; ocelli blackish with yellow centers and rarely with small dark central blotch (Fig. 30); blackish temporal band, framed below by a light stripe. *Varanus rainerguentheri*.
4. Temporal band absent (Fig. 18). Go to 5.
  - Temporal band present (Fig. 16). Go to 6.
5. Ground coloration in adults yellow with a more or less developed dark marbling (Fig. 27); in contrast, the hatchlings are blackish with a light pattern of transverse rows of yellow ocelli (Fig. 28); throat unpatterned; low midbody scale counts (124–133). *Varanus melinus*.
  - Dorsum greyish-brown to blue-grey, with transversal rows of ocelli; tail with blue coloration (Fig. 17); densely marbled throat (Fig. 18); high midbody scale counts (154–180). *Varanus doreanus*.
  - Dorsum dark brown, charcoal grey or black, often with dispersed single tan or pale yellowish brown scales (Fig. 29), most evident on nape and sacral regions (from a distance the dorsum appears uniformly glossy black); low midbody scale counts (119–134). *Varanus obor*.
6. Throat pinkish, reddish or orange ("peach-throated monitor lizard"); angular head with conspicuous large eyes; slender species with long neck and distinct pointed head; dark olive dorsum with dark transversal banding and numerous tiny light spots; tail is blue-turquoise banded (Fig. 21). *Varanus jobiensis*.
  - Throat light (but not pinkish, reddish or orange), with or without few spots; no distinctly enlarged eyes. Go to 7.
7. Yellow ground coloration in adults (Fig. 27); in contrast to the yellow ground coloration of the adults with a more or less developed dark marbling, the hatchlings are blackish with a light pattern of transverse rows of yellow ocelli (Fig. 28); throat unpatterned; low midbody scale counts (124–133). *Varanus melinus*.
  - Adult ground coloration different. Go to 8.
8. Distinct ocellated dorsal pattern in adults, without turquoise tinge and without large crossbands; dorsum grey with transversal pattern of light ocelli, that are framed by black and contain a small dark center (Fig. 19); whitish throat with few small grey blotches; dark temporal band, that is bordered above and below by a row of light blotches. *Varanus finschi*.
  - If at all, only rudimentary ocellated pattern in adults; dorsum instead either with distinct turquoise tinge or few large dark transversal crossbands; moderate to high midbody scale counts (131–185). Go to 9.
9. Light blue to turquoise tinge of the head, neck, body, dorsum, limb and tail coloration (Figs. 13, 14); dorsum with more or less discernible rows or rudiments of rows of ocelli; temporal band dark, framed by yellowish to turquoise scales; high midbody scale counts (170–185). *Varanus caerulivirens*.
  - Crossbanded dorsal pattern in adults (Fig. 15), quite distinct from the juvenile pattern, that consists of adjacent rows of light-centered ocelli; existence of a well-defined yellow, 1–4 scales wide temporal stripe, bordered above and below by dark bands (Fig. 16); medium midbody scale counts 131–150; entire light tongue only in juveniles; lack of blue coloration in the tail. *Varanus cerambonensis*.

### IV. Subgenus *Philippinosaurus*:

1. Dorsal side black (Fig. 45) with scattering of tiny yellow dots on the posterior end of some scales of neck, back and extremities; 212 scales around the midbody. *Varanus mabitang*.
  - Dorsal side not black (Fig. 47), with a pattern; 175–193 scales around the midbody. Go to 2
2. Dorsal side greenish grey with darker transverse bands across neck, back, and tail, and extremities irregularly mottled yellowish-olive and grey (Fig. 47); about 193 scales around the midbody. *Varanus olivaceus*.
  - Dorsal side black covered with contrasting golden yellow spots and flecks; 175–193 scales around the midbody. *Varanus bitatawa*.

### V. Subgenus *Empagusia*

1. Scales of the nape distinctly enlarged (Figs. 7, 10). Go to 2.
  - Scales of the nape not enlarged, not or only slightly larger than dorsal scales. Go to 3.
2. Scales of the nape irregularly arranged; juveniles with orange coloration on head and nape (Fig. 6); 66–102 scales around the midbody. *Varanus dumerilii*.
  - Scales of the nape extremely enlarged (Fig. 10), forming 10–12 clear longitudinal rows; juveniles without orange (Fig. 9); 139–169 scales around the midbody. *Varanus rudicollis*.
3. Large midbody scales, resulting in a low number of scales around the midbody (82–94); nostril located somewhat closer to snout tip than to eye (Fig. 8). *Varanus flavescens*.
  - Small midbody scales, resulting in a high number of scales around the midbody (139–165); nostril located somewhat closer to eye than to snout tip. Go to 4.
4. Supraocular scales not differentiated (Fig. 3). *Varanus bengalensis*.
  - Supraocular scales differentiated (Fig. 61). *Varanus nebulosus*.

**VI. Subgenus *Soterosaurus* (*Varanus salvator* complex):**

1. Scales of nape region enlarged (19–33 scales from hind margin of tympanum to gular fold), much larger than dorsal scales (Fig. 52). Go to 2.
    - Scales of nape region not enlarged (26–52 scales from hind margin of tympanum to gular fold), not or only slightly larger than dorsal scales. Go to 5.
  2. Dorsally whitish, with 6–11 more or less distinct dark pointed bars or crossbands; 24–33 scales ( $x = 28$ ) scales from hind margin of tympanum to gular fold; 115–145 ( $x = 133$ ) scales around midbody; restricted to Luzon Island, Philippines. *Varanus marmoratus*.
    - Dorsal color pattern different, without intensive black and yellow pattern (Figs. 51, 52). Go to 4.
  3. Head predominantly yellow; back with 5–6 indistinctive yellow transverse rows, sometimes with medio-dorsal stripe (Fig. 48); belly yellow, with 8–11 more or less distinctive dark bars or crossbands; restricted to Mindanao Island. *Varanus c. cumingi*.
    - Head predominantly black; back with 6–8 transverse rows of more or less distinctive yellow spots, ocelli or markings (Fig. 49); belly yellow, with 9–15 more or less distinctive dark bars or crossbands; restricted to Samar, Leyte, and Bohol islands. *Varanus cumingi samarensis*.
  4. Head without light areas (Fig. 51); dorsally dark, with or without 4–6 transverse rows of more or less distinctive larger light spots; ventrally whitish, with 6–11 more or less distinct dark pointed bars or crossbands; 24–33 scales ( $x = 28$ ) scales from hind margin of tympanum to gular fold; 115–145 ( $x = 133$ ) scales around midbody; restricted to Luzon Island, Philippines. *Varanus marmoratus*.
    - Color pattern variable, head with or without light areas (Figs. 52, 53); dorsally dark, with or without four more or less reduced transverse rows of light spots, sometimes with bright medium stripe; ventrally entirely dark or yellowish with dark reticulate markings or indistinctive dark bars; 19–30 ( $x = 23$ ) scales from hind margin of tympanum to gular fold; 136–169 ( $x = 151$ ) scales around midbody; restricted to Negros-Panay region, Philippines. *Varanus nuchalis*.
  5. Dorsally dark with more or less distinct transverse rows of large light spots or ocelli (Figs. 56–59). Go to 6.
    - Dorsally entirely black, sometimes with a small light dot on each scale (Fig. 62), sometimes with irregularly scattered larger light dots or spots, but never forming distinct transverse rows; sometimes a light longitudinal stripe along the neck is present; throat dark, with or without distinctive light rectangles (Fig. 63); restricted to Togian Islands, Sulawesi. *Varanus togianus*.
    - Dorsal and ventral side black without any light markings; restricted to Malaysian peninsula. *Varanus salvator macromaculatus* (melanistic form).
  6. Dorsum with four to seven distinct transverse rows of large light spots or ocelli (Fig. 56); without whitish markings on head; tongue dorsally and ventrally dark pigmented. Go to 7.
    - Dorsum with more than seven more or less distinct transverse rows of light spots (Fig. 55); sometimes with whitish markings on head; tongue sometimes only above dark pigmented. Go to 9.
  7. Dorsal ground color brown; first dorsal transverse row behind the fore limbs sometimes fused to a continuous crossband or reduced; often with light marbling, but no line of light dots between the transverse rows; a light longitudinal stripe along the neck sometimes present; 116–189 dorsal scale rows from hind margin of tympanum to insertion of hind limbs. Go to 8.
    - Dorsal ground color black; first dorsal transverse row always with well-defined large light spots or ocelli; without light marbling between the transverse rows, but often with a line of light dots in between (Fig. 56); a light longitudinal stripe along the neck absent; 118–135 dorsal scale rows from hind margin of tympanum to insertion of hind limbs; restricted to Sri Lanka. *Varanus s. salvator*.
  8. First dorsal transverse row behind the fore limbs often fused to a continuous cross band (Fig. 57); neck with large lateral dark blotches and spots; sometimes with a light median stripe on dorsum; restricted to Java and Lesser Sunda Islands. *Varanus salvator bivittatus*.
    - First dorsal transverse row behind the fore limbs usually not fused to a continuous cross band (Fig. 58); neck without large lateral dark blotches; restricted to mainland Southeast Asia, Sumatra, and Borneo. *Varanus salvator macromaculatus*.
    - Dorsum dark, in juveniles with up to six transverse rows of largely reduced light spots, adults without light dorsal spots; restricted to the Andaman Islands. *Varanus salvator andamanensis*.
    - Head and neck light brown; first dorsal transverse row behind the fore limbs reduced, particularly in adults; remaining dorsal light spots large and dark encircled forming distinct ocelli (Fig. 59); restricted to the Moluccan Islands. *Varanus salvator ziegleri*.
  9. Head dark, without whitish markings, a bright temporal streak only in juveniles; juveniles dorsally brown with about 12 transverse rows of small spots (Fig. 55); adults dark brown, mottled with single bright scales; juveniles ventrally whitish with about 11 dark cross bars; adults dark with indistinctive bright median bars; 120–129 scales around the neck; 152–157 ( $x = 154.50$ ) scales around midbody; restricted to Sulu Islands, Philippines. *Varanus rasmusseni*.
    - Head mostly dark, sometimes with whitish markings (Fig. 54), a bright temporal streak more or less pronounced; adults dorsally mostly dark, mottled with light bordered scales; particularly juveniles with up to eight transverse rows of reduced light spots; ventrally whitish, with 7–11 more or less distinctive dark crossbands; 93–116 scales around the neck; 129–178 ( $x = 141.93$ ) scales around midbody; restricted to Palawan region, Philippines. *Varanus palawanensis*.
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