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Geographical Distribution and Regional Variation of *Varanus salvator macromaculatus* in Thailand

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Abstract: The geographical distribution of *Varanus salvator macromaculatus* in Thailand has not been accurately recorded in previously published literature, which has either concluded it is present throughout Thailand or absent only from northern-most Northern Thailand. Here, the geographical distribution is mapped out for Thailand and Laos using documented localities and the findings of this study. Our findings show that *V. salvator macromaculatus* is absent from most of Northern and nearly all of Northeastern Thailand; it is further described for adjacent countries. The geographical variation of *V. salvator macromaculatus* is recorded and discussed, which can be of aid to biologists and wildlife trade enforcement officials in order to protect the species from the illegal wildlife trade.

Introduction

Varanus salvator was described in 1768 by Austrian naturalist Josephus Nicolaus Laurenti. Today, this species has among the widest distribution of all varanids, ranging from Sri Lanka in the west through continental Southeast Asia, the Greater and Lesser Sunda Islands and the Philippines, finally reaching Sulawesi in the east. The form in Thailand was designated as the nominate form, *V. salvator salvator* until Deraniyagala wrote a paper in 1947 on the different races of *V. salvator* in which he described it as *V. salvator macromaculatus*. This subspecies epithet remained in synonymy with *V. s. salvator* until Koch et al. (2007), when *V. salvator* was reviewed; many subspecies were elevated to species status, *V. salvator macromaculatus* was raised again as a subspecies with Siam (Thailand) as *terra typica*. Another Thai form, the melanistic *V. salvator komaini* was placed as a synonym of *V. salvator macromaculatus* (Koch et al., 2007).

In Thailand, *V. salvator macromaculatus* is protected from hunting, collection and export without special permits by Thai Law (1992). This same protection also hinders research; therefore, this species has been neglected in study (Cota, 2009). Another reason why there has been little study of this species is because of the negative attitude brought by the species name in Thailand, which is considered the lowest and dirtiest animal in the culture. The name of this magnificent species, "hia", has become a curse word in Thailand and a substitute word, "tua ngern tua tong", has substituted it so this species can be talked about politely in public. Recently, the word "Varanus" was suggested as a substitute, but because a similar name is already in usage, it was the subject of protest and misunderstanding, which prompted a publication to educate the public (Chan-ard, 2009). Since it has been despised and subsequently neglected, no nation-wide study has been conducted on this species in the past. Its geographic distribution has been simply described as 'throughout Thailand' in all literature (Taylor, 1963; Cox et al. 1998 by implication; Nabhitabata and Chan-ard, 2005), except those which only recorded locality data, such as Nabhitabhata et al. (2000).

During field studies of *V. salvator macromaculatus*, a number of regional variations have been found. These variations are described along with the geographic locations that they can be found.

Geographical Distribution in Thailand

There have been a number of maps showing the geographic distribution of *V. salvator*. Every one of these maps has shown the entirety of Thailand (Bennett, 1998;

Gaulke and Horn, 2004; Koch et al., 2007) which might be based on the information in Taylor (1963) or all of Thailand with the exception of the northern- most extent of Northern Thailand (Eidenmüller, 2007; Eidenmüller and Philippen, 2008) as being the extent of natural geographic distribution for this species. To date, there is no field guide with distribution maps for the reptiles of Thailand. Descriptions of the geographic distribution of *V. salvator* have not been specific, either listing all of Thailand and citing Smith (1935) and Taylor (1963), or Southeast Asia, citing Mertens (1942) and Cox et al. (1998). Because of the enormous range of this species, it is possible that errors in the past may have been a result of an overestimation of geographical distribution in a species with one of the greatest distributions of all monitor species. The only publications that have dealt specifically with this species' geographic distribution in Thailand to date have been Taylor (1963), which claimed it was found throughout Thailand, albeit with no specific locality data in the areas this study shows them to be absent; Nabhitabhata et al. (2000), which was solely based on locality data and Lauprasert and Thirakupt (2001), which documented localities in Southern Thailand; Nabhitabhata and Chan-ard (2005) described distribution as all of Thailand, following past literature.

Although Thailand has a very large population of *V. salvator macromaculatus* due to their protected status and lack of predators, this species is mostly absent in the geographical/political region of Northern Thailand. As depicted in Fig. 1, the furthest northern extent of its range in Northern Thailand is a population in Sukhothai (this study). With the exception of a mountain range between Central and Northeastern Thailand (Nabhitabhata et al. 2000), *V. salvator macromaculatus* barely reaches the Korat Plateau, which makes up the topography of the geographical and political area known as Northeastern Thailand, also referred to as the Isaan Region (this study). It is most common in the flood plains of the Chao Phraya River flood basin, even into the middle of Bangkok where there are large thriving populations with large population densities and in the mangrove forests to the south of Bangkok (this study).

To the west of Thailand, it is absent from central Myanmar (Zug, pers. comm.), but has been recorded once, 130 years ago, in the north of Myanmar, in Bhato (Anderson, 1879 cited in Mertens, 1942) and again in the Kakhien (Kachin) Hills of Myanmar, which is in the same region (Boulenger, 1888, cited in Mertens, 1942). The areas of Bhato and the Kachin Hills represent the source of the Irrawady River. Could these localities be based on specimens obtained in markets, transported as food? Could these localities have been in error like many localities for *V. salvator* recorded in the mid to late 19th century, such as South Africa (Gray, 1845 cited in Mertens, 1942) and Cape York in Australia (Boettger, 1888 cited in Mertens, 1942) or had *V. salvator* dispersed up the Irrawady River north to its source and has not been recorded in the north since? The California Academy of Sciences (CAS) has conducted numerous surveys of Myanmar (Burma), but has not recorded *V. salvator* in central or northern regions of the country. To the north of Thailand, it is absent in northern Laos and is only recorded in southern and eastern Laos in the northern and central areas of the Annamite Mountains, which separate Laos and Vietnam. One record shows it in the plains west of the Annamite Mountains (Duckworth et al. 1999). To the east of Thailand in Cambodia, its geographic distribution extends to the southeast along the Cardamom Mountains following the coastal areas to eastern Cambodia, and is found in the hilly areas of northeastern Cambodia (Stuart, unpubl. data); it has also been found in Cambodia along the Mekong River (Bezuijen et al., 2009). South of Thailand, the geographical distribution is continuous south past the tip of peninsular Malaysia to Singapore and beyond into Indonesia, as described in historical literature (Mertens, 1942; Bennett, 1998; Gaulke and Horn, 2004; Koch et al., 2007; Eidenmüller, 2007; Eidenmüller and Philippen, 2008)

One can only speculate as to why *V. salvator macromaculatus* has not expanded its geographic distribution further north into Northern Thailand and Northeastern Thailand. One reason that they have not expanded further north and northeast could be due to the xeric habitats of these regions resulting from a dry climate during the cold season, from November to February, and the hot season, from March to June. During these seasons, large areas are without permanent water sources, which *V. salvator* is completely dependent. Even within its geographical distribution, *V. salvator macromaculatus* in Thailand is not found more than 200 m away from a water source, with the exception of torrential downpours during the rainy season (Cota, pers. obs.). Another reason that *V. salvator macromaculatus* may not have expanded its geographic distribution further north and northeast may be time constraints; it may not have had the time to disperse further inland from the time it appeared in Thailand. There are riparian habitats along the Ping River, Nan River and Yom River that *V. salvator macromaculatus* could exploit from its furthest distribution north in order to expand its range

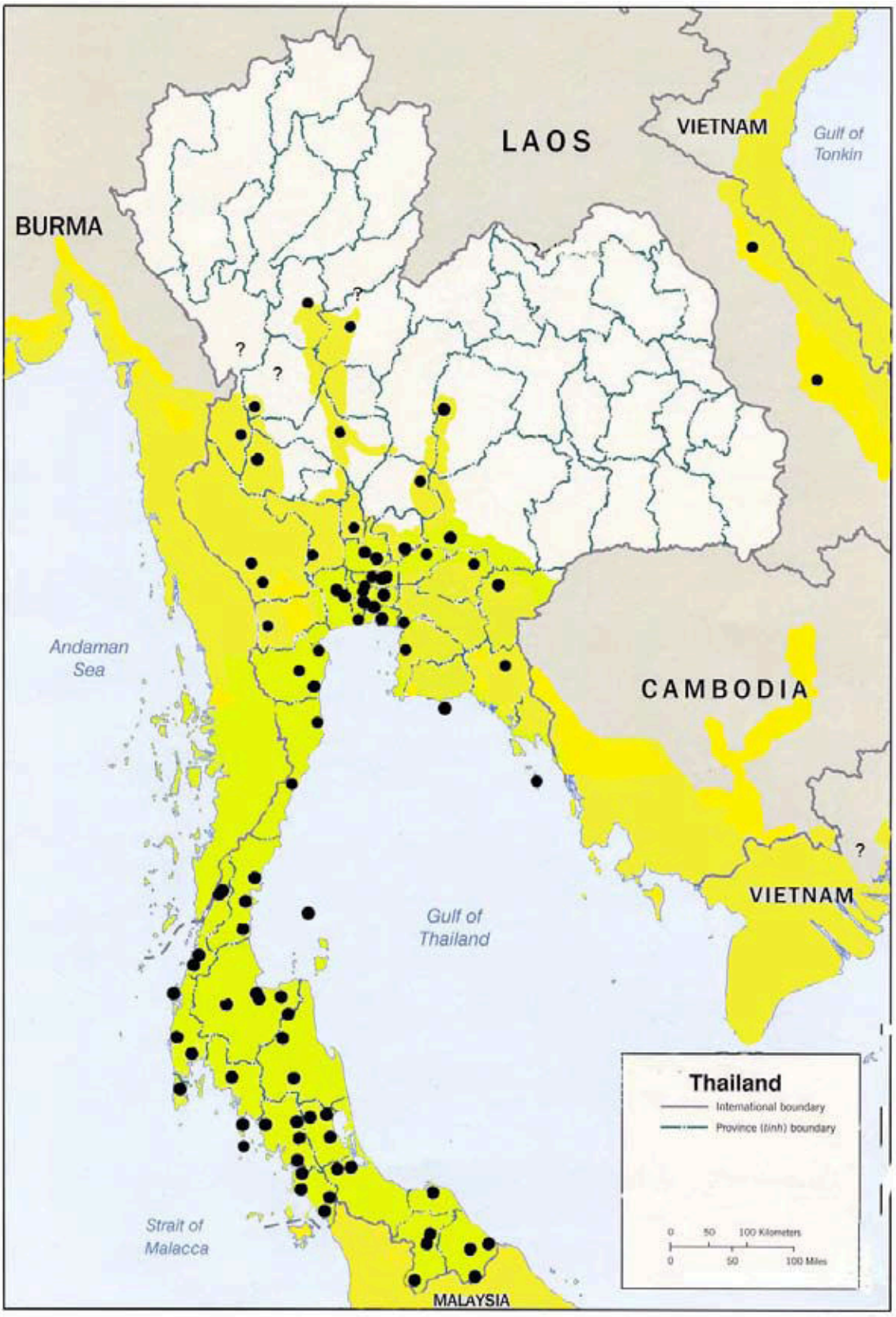

Fig. 1. Geographic distribution of *Varanus salvator macromaculatus*, based on locality data provided in Table 1.

deep into mountainous Northern Thailand, but it has not, as it had possibly done in the past along the Irrawady River in Myanmar and has already done up the Chao Phraya River in Thailand. It has also not exploited the riparian habitats up the Mekong River, along the border between Laos and Thailand. Although *V. salvator macromaculatus* is seen in the open sea, it is not often seen in the largest rivers in Thailand, like one would find *V. niloticus* in Africa (Cota, pers. obs.). Massive deforestation and habitat destruction for agriculture in Northeast Thailand that has taken place over the past decades ensures that *V. salvator macromaculatus* will not disperse into the Khorat Plateau, which makes up Northeast Thailand. Numerous interviews of the elderly in the northeast region of Thailand confirm that there was no historical *V. salvator* presence many decades ago when the entire area was forested and the only monitor lizard known was referred to as "Lan", which refers to *V. bengalensis nebulosus* in Lao and the Isaan (Northeast Thailand) dialect.

Examination of the true geographical distribution of the *V. salvator* complex, shows a continuous coastal and near the coast distribution. This geographical distribution becomes more broken up as one continues inland and necessarily so since the geographic distribution becomes tied to permanent water sources and riparian habitat. Where there are no permanent water sources, one will not find *V. salvator.*

Regional Variation

Before this study, specifically before Koch et al. (2007), there were two regional variations of *V. salvator* known in Thailand. This was the common variation found throughout Thailand and the form that was previously known as *V. salvator komaini*. During the conduct of this study, 5 different variations of *V. salvator macromaculatus* were identified primarily based on geography with one that may be based on habitat. These variations are strictly on the basis of pattern, no morphometric data has been taken or morphological differences studied to further separate them.

The most common geographical variation of *V. salvator macromaculatus* is found in central Thailand, throughout the Chao Phraya River basin and extends north in the mountains that separate Central Thailand from Northeast Thailand (Isaan); westward, its range extends over mountainous western area of Thailand and over the border with Myanmar; southward, it extends into peninsular Thailand. This form is boldly marked with bands of large ocelli, which represent the subspecies epithet and should be considered the *terra typica* form, as represented in the photograph showing *V. salvator macromaculatus* in Koch et al. (2007) and Fig. 2.

Another variant of *V. salvator macromaculatus* that is well known is the form previously known as *V. salvator komaini*, until Koch et al. (2007), made it a synonym of *V. salvator macromaculatus*. This form is found in the mangrove forests of the La-Ngu District of Satun Province and the islands off shore. It is occasionally found across the provincial boundary into Trang Province, but it rarely encountered there. There is no record of this form from south of the La Ngu District. This is the only completely melanistic population recorded for the

Fig. 2. Juvenile of *V. salvator macromaculatus* from the Chao Phraya River flood plain of central Thailand. Photograph by **Michael Cota.**

V. salvator species complex. It is completely melanistic and patternless from the time it hatches. This form is known as the Black Dragon from its *V. salvator komaini* description (Nutphand, 1987) and by the international pet trade on the occasions it has been smuggled out of Thailand (Cota, 2009) (Fig. 3).

In parts of southern peninsular Thailand, there is a form of *V. salvator macromaculatus* that is similar to that which is found more often in peninsular Malaysia and Singapore, which is gray in overall coloration with a subdued pattern. The pattern is bolder in juveniles, but becomes more subdued and gray as the monitor matures (Fig. 4).

Fig. 3. Adult of melanistic population of *V. salvator macromaculatus*, previously known as *V. salvator komaini*, from the La-ngu District, Satun Province of Southern Thailand. Photograph by **Michael Cota.**

In the mangrove forests of Thailand, there is a form of *V. salvator macromaculatus* that possesses an overall dark subdued pattern. It is similar to the most common geographical variation in Thailand, but the bright yellow markings are subdued with black to a point where it is hardly visible. Subadults are already nearly without a pattern. The common Thai geographical variant is also sometimes found in the mangrove forest, but the subdued mangrove form is only found in the mangrove forests or in geographical locations not too distant from mangrove forests (Fig. 5).

Eastern Thailand has a form of *V. salvator macromaculatus* which is similar to the more common form, but possesses smaller ocelli which make the black bands appear larger. In Eastern Thailand, the more common pattern also appears, but is exceptional (Fig. 6).

Saraburi Province has a variant that is quite possibly the most attractive of all variations in Thailand. This is a high yellow variant with solid yellow/white spots in the place of ocelli. The great amount of yellow in the pattern is possibly due to the arid climate, among the most arid in which *V. salvator macromaculatus* is to be found in Thailand (Fig. 7).

Fig. 4. Adult *V. salvator macromaculatus* from Phuket Province of Thailand. Photograph by **Suwit Punnadee** (Wild Animal Rescue Foundation of Thailand).

Fig. 5. Young adult *V. salvator macromaculatus* from the mangrove forest of Samut Prakarn Province of Thailand. Photograph by **Michael Cota**.

Fig. 6. Sub-adult of *V. salvator macromaculatus* from Khao Yai National Park, in the eastern part of its geographical distribution in Thailand. Photograph by **Michael Cota**.

Fig. 7. Juvenile of *V. salvator macromaculatus* from the arid area of Saraburi, Thailand, on the edge of its continuous geographical distribution within Thailand. Photograph by **Michael Cota**.

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Table 1. Documented localities of *Varanus salvator macromaculatus* in Thailand.

Province	**District/Area**	**Source**
Angthong		Flower, 1899, cited in Mertens, 1942
Ayutthaya	Pahang	Flower, 1899, cited in Mertens, 1942
Ayutthaya	Muang	Flower, 1899, cited in Mertens, 1942
Bangkok		Flower, 1899, cited in Mertens, 1942
Pattani		de Rooj, 1917, cited in Mertens, 1942
Surat Thani	Koh Tao	Cochran, 1930, cited in Mertens, 1942
Satun	La Ngu	Nutphand, 1987
Pang Nga	Khao Lak-Lam Ru MNP	Chan-ard et al., 1999
Nakhon Ratchasima	Khao Yai National Park	Chan-ard et al., 1999
Bangkok	Bang Khen	Nabhitabhata et al., 2000
Chaiyaphum	Khao Khieo NP	Nabhitabhata et al., 2000
Chumphon	Muang	Nabhitabhata et al., 2000
Chumphon	Sawee	Nabhitabhata et al., 2000
Chumphon	La Ma	Nabhitabhata et al., 2000
Chumphon	Mu Ko Phayam	Nabhitabhata et al., 2000
Nakhon Si Thammarat	Tai Rom Yen	Nabhitabhata et al., 2000
Nakhon Si Thammarat	Thung Son	Nabhitabhata et al., 2000
Narathiwat	Ruso	Nabhitabhata et al., 2000
Narathiwat	Tak Bi	Nabhitabhata et al., 2000
Narathiwat	Hala-Bala WS	Nabhitabhata et al., 2000
Pattani		Nabhitabhata et al., 2000
Phatthalung	Khao Pu Khao Ya NP	Nabhitabhata et al., 2000
Phuket	Khao Pra Taew WC	Nabhitabhata et al., 2000
Ranong	Kra Buri	Nabhitabhata et al., 2000
Ranong	Suk Sam Ran	Nabhitabhata et al., 2000
Sa Kaeo	Pang Sida NP	Nabhitabhata et al., 2000

Table 1. *continued.*

Province	District/Area	Source
Surat Thani	Phun Phin	Nabhitabhata et al., 2000
Surat Thani	Khao Sok NP	Nabhitabhata et al., 2000
Surat Thani	Kanchanadit	Nabhitabhata et al., 2000
Trang	Khao Pu Khao Ya NP	Nabhitabhata et al., 2000
Trang	Khao Chong WC	Nabhitabhata et al., 2000
Uthai Thani	Huay Kha Kaeng WS	Nabhitabhata et al., 2000
Yala	Bannang Sata	Nabhitabhata et al., 2000
Yala	Betong	Nabhitabhata et al., 2000
Pathum Thani	Rangsit	National Science Museum (TH), 2001
Krabi	Mu Ko Lunta MNP	Lauprasert and Thirakupt, 2001
Krabi	Khao Phanom	Lauprasert and Thirakupt, 2001
Narathiwat	Hala-Bala WS	Lauprasert and Thirakupt, 2001
Narathiwat	Sirindhorn Peat Swamp RNC	Lauprasert and Thirakupt, 2001
Pang Nga	Sri Nang Nga NP	Lauprasert and Thirakupt, 2001
Pang Nga	Ao Pang Nga MNP	Lauprasert and Thirakupt, 2001
Phatthalung	Khao Pu Khao Ya NP	Lauprasert and Thirakupt, 2001
Phatthalung	Thale Noi NA	Lauprasert and Thirakupt, 2001
Ranong	Lumnum Kraburi NP	Lauprasert and Thirakupt, 2001
Ranong	Mu Ko Payam MNP	Lauprasert and Thirakupt, 2001
Satun	Nong Prag Praya NA	Lauprasert and Thirakupt, 2001
Songkla	Ton Nga Chang WRS	Lauprasert and Thirakupt, 2001
Songkla	Hat Yai NWSC	Lauprasert and Thirakupt, 2001
Surat Thani	Muang	Lauprasert and Thirakupt, 2001
Trang	Had Chao Mai MNP	Lauprasert and Thirakupt, 2001
Phetchaburi	Ban Lat	Pauwels et al., 2003
Phetchaburi	Ban Laem	Pauwels et al., 2003
Chachoengsao	Bang Pakong	Sukprakarn, pers. comm.
Ayutthaya	Muang	This study
Ayutthaya	Pang Pa-In	This study
Ayutthaya	Wang Noi	This study
Bangkok	Dusit	This study
Bangkok	Lumpini	This study
Kanchanaburi	Muang	This study
Kanchanaburi	Sai Yok	This study
Krabi	Muang	This study
Lop Buri	Tha Wung	This study
Nakhon Pathom	Nakhon Chaisi	This study
Nakhon Pathom	Phuttamonthon	This study
Nakhon Pathom	Salaya	This study
Nakhon Sawan	Bueng Boraphet	This study
Nonthaburi	Bang Bua Thong	This study
Nonthaburi	Bang Yai	This study
Pathum Thani	Khlong Luang	This study
Pathum Thani	Muang	This study
Pathum Thani	Thanyaburi	This study
Phetchaburi	Cha-Am	This study
Phitsanulok	Kaeng Jed Kwae NP	This study

Table 1. *continued*

Province	District/Area	Source
Prachin Buri	Tablan NP	This study
Prachuap Khiri Khan	Ao Manao	This study
Prachuap Khiri Khan	Pranburi	This study
Ratchaburi	Suan Pueng	This study
Rayong	Koh Man	This study
Sing Buri	Prom Buri	This study
Saraburi	Muak Lek	This study
Sukhothai	Muang	This study
Tak	Huai Kha Kaeng WS	This study

Abbreviations used:

MNP	Marine National Park
NA	Non-Hunting Area
NP	National Park
RNC	Research and Nature Study Center
WC	Wildlife Conservation Development and Extension Center
WRS	Wildlife Research Center
WS	Wildlife Sanctuary

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