

THE CURRENT AND HISTORIC DISTRIBUTION OF *TOMISTOMA SCHLEGELII* (THE FALSE GHARIAL) (MÜLLER, 1838) (CROCODYLIA, REPTILIA)

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ABSTRACT. – *Tomistoma schlegelii* the “False Gharial” (Müller, 1838) is one of the largest yet least-known of the world’s 23 crocodylian species, restricted to Indonesia and Malaysia. We compiled and mapped 210 records and overlaid these against geological river systems and current vegetation, in order to assess historic and current distribution, relationship to key habitats and potential centres of current abundance. The current distribution of *T. schlegelii* extends over lowland regions of eastern Sumatra, Kalimantan and western Java (Indonesia), Sarawak and Peninsular Malaysia, Vietnam and Thailand, within 5 degrees north and south of the equator. Additional records from Sabah (Borneo) and Thailand are unconfirmed, and early records from Thailand may have originated from regions currently within Peninsular Malaysia. The Pliocene to early Pleistocene distribution of *T. schlegelii* was apparently much broader than its historical range, and extended over lowland river systems of Indonesia, Malaysia and into southern China. Since the discovery of the species in 1838, a significant decline in the density of populations throughout range states has occurred, more markedly since the 1940s. Ironically, the broad outlines of the original distribution seem to have remained. A large portion of the records appear to be associated with peat swamp forest, a highly threatened category of tropical forest, suggesting that a decline in abundance is related to habitat loss. Current areas in which the species appears to still maintain reasonable levels of abundance are in southern Sumatra, west Kalimantan and south-central Kalimantan, although some smaller protected populations occur in central Sarawak. Current *T. schlegelii* breeding habitats are under threat throughout range states as a result of the progressive draining, logging, burning and clearing of swamp forests.

KEY WORDS. – *Tomistoma*, false gharial, peat swamp, crocodylian.

INTRODUCTION

Tomistoma schlegelii, or “False Gharial” (Müller, 1838) is a large (4-5 m total length), freshwater crocodylian whose extant distribution is restricted to Indonesia (east Sumatra, west Java and Kalimantan) and Malaysia (Sarawak and Peninsular Malaysia). The species was first described from “southern Borneo” (currently Kalimantan, Indonesia). It is one of the least-known of the world’s 23 extant crocodylian species and is listed as globally “Endangered” by the IUCN-World Conservation Union (Thorbjarnarson, 1992; Ross, 1998b; www.redlist.org). To date, there have been no long-term autecological studies of the species, and most available information is from a small number of rapid status

assessments conducted between 1985 and 2004 (Bezuijen, et al., 1995, 1997, 2001b, 2002a, b; Bezuijen, 2004; Cox and Gombek, 1985; Frazier, 1994; Frazier and Maturbongs, 1990; Muin and Ramono, 1994; Ramono, 1994; Ross et al., 1998; Sebastian, 1993a,b; 1994; Simpson et al., 1997; Simpson, 2004). Key findings from these limited data indicate that the preferred nesting habitat of *T. schlegelii* is peat or freshwater swamp forest, and that the species appears to occur at low densities throughout most of its range (Bezuijen et al., 1998, 2001a; Stuebing et al., 2004).

Peat swamp forest is one of the most threatened tropical forest ecosystems in South-east Asia and under intensive loss or degradation from indiscriminate harvest of wood, forest fires

and swamp reclamation (Rieley and Page, 1997; Stibig et al., 2002). In Borneo, <50% (95,000km²) of original swamp forest is estimated to remain (WCMC, 2000). This has resulted in extensive loss of documented and potential *T. schlegelii* nesting habitat (Bezuijen et al., 2002a, b; Bezuijen, 2004). In this paper, we map the current and historic global distribution of *T. schlegelii* and evaluate these data to identify areas where viable populations of the species may still occur, and to make an initial assessment of whether there have been significant changes in the overall geographic distribution of the species in recent (e.g., post 1940) times.

METHODS

Study area

Sumatra, Borneo and Peninsular Malaysia are located within the biogeographic region “Sundaland”, referring to South-east Asian countries located on the shallow (≤ 100 m depth) Sunda shelf of the South China Sea (Voris, 2000). Mean annual ambient temperatures experience a low range and humidity is high (e.g. 23-31°C and 85% respectively in Sumatra; Whitten et al., 1987). A distinct “wet” (November-February) and “dry” (March-September) season occurs, although the wet season is extended in Sumatra, lasting from October-April. In Sumatra, Java, Borneo, and Peninsular Malaysia mean annual rainfall ranges from 2,500-3,500 mm, with peak rainfall from December to March (Whitmore, 1984; Whitten et al., 1996; Meteorological Department, Sarawak; Malaysian Meteorological Department, Kuala Lumpur). Large, meandering rivers dominate the lowlands, and tidal influence extends up to 100 km inland and well into totally freshwater areas. Tidal range is highly variable between regions, and there is generally one tidal cycle per day, but can be two per day during neap tides, with a tidal range of 5 m in some areas (Hadi et al., 1977; ISDP, 1997).

Most lowland regions of Sumatra, Borneo and Peninsular Malaysia historically have contained extensive peat and freshwater swamp forest habitats, e.g., forests that are inundated for a significant portion of the year, and because of their acidity and anaerobic character, often contain layers of organic detritus in the form of peat. Borneo and Sumatra, where the largest area of these habitats are located, historically supported approximately 220,000 km² of peat swamp forest (including 154,000 km² peat swamp forest), which has been reduced to approximately 95,000 km² due to development activities (a loss of <50%); substantial remnants (>20,000 km²) remain in the middle Sg [= River] Mahakam, in central and western Kalimantan (WCMC, 2002). In Sumatra, most swamp forests are located in a large belt of low-lying, tidal floodplains, termed the ‘Eastern Lowlands’, which extend from southern to northern Sumatra. These lowlands comprise some 18% (88,000 km²) of the island, mostly in the provinces of Riau, Jambi and South Sumatra (Claridge, 1994), and consist mainly of alluvial and marine deposits, frequently overlain by a layer of peat that may reach depths of 20 m (Danielsen and Verheugt, 1990).

Tomistoma schlegelii records

Records were assigned to one of three categories reflecting their validity: “1” - museum specimens with information on date, collector and full or partial locality data, e.g. river or district name; “2” - first-hand field observation by the authors; or, an observer who related the record directly to one of us and correctly described the species, locality and date; or, captive specimen observed by the authors in the source region and for which information on capture location and date was given by the original collector; “3” - first- or second-hand field observation by a non-scientist, usually a local villager, in which a general location and/or date is given but few other details, and which was related to the authors or another scientist. Other records (second- and third-hand information) were excluded from compilation. Categories 1 and 2 were regarded as “confirmed” records and category 3 records as “unconfirmed”. Wherever possible, reliability, location, collector, date and geographic coordinates (latitude/longitude) were collected for each record. Multiple records for a single site were treated as independent records if the authors of survey reports had accounted for and removed potential repeat-sightings (i.e. four separate sightings in a single river were compiled as four separate records). If this was not clear, then multiple records for a single site from a single survey, were compiled as a single record. Authors of recent reports describing *T. schlegelii* sightings were contacted for GPS or map coordinates of records. For records with adequate descriptions but no map coordinates (especially museum specimens), a map coordinate was obtained from regional topographic maps. For these records, coordinates were assigned to a location above the limit of saltwater intrusion, as we assumed that the *T. schlegelii* only occurs in freshwater habitats.

The following records were excluded from compilation: all records (including museum specimens) with no locality information or vague locality descriptions (e.g. a record only stating “Perak River, Malaysia” – this river is >200 km long); captive specimens of uncertain origin (usually those observed in trade or on crocodile farms some distance from a potential source region); “third-hand” reports; and, “eyeshine” records (where a crocodilian was sighted in a survey but the species was not confirmed).

Mapping and data analysis

Records were plotted in a ArcView 3.2 geographic information system and overlaid on a 1: 5 500 000 scale vegetation map of south-east Asia (source “cartographic digital products” at <http://www-gvm.jrc.it/Forest/defaultForest.htm>). Records were analysed for: (1) extent of global coverage and distribution within south-east Asia; (2) extent of overlap in records, at sites with repeat records; (3) implications of any habitat preference by *T. schlegelii*.

RESULTS

Historic distribution

A total of 210 *T. schlegelii* records were compiled, dating from 1838-2004 (Table 1; Appendix 1): 41 category “1”, 117

Table 1: Summary of False Gharial presence records 1838 - 2004

Region	Records (categories 1-3)*			Total specific localities	Admin. regions	Total Records
	1	2	3			
INDONESIA						
<i>Sumatra</i>						
Aceh Province	0	0	0	0		
North Sumatra Province	5	0	0	3		
Riau Province	2	8	4	8		
Jambi Province	1	20	2	9		
South Sumatra Province	4	57	0	12		
Lampung Province	0	3	1	2		
West Sumatra Province	0	0	(2)	(2)*		
Total	12	88	9	36	7	109
<i>Kalimantan</i>						
East Kalimantan Province	1	2	18	20		
West Kalimantan Province	8	3	5	10		
Central Kalimantan Province	1	12	0	3		
South Kalimantan Province	2	0	0	1		
Total	11	17	23	34	4	51
<i>Java</i>						
Banten Province	1	1	0	2	1	
Total	1	1	0	2	2	2
MALAYSIA						
<i>Peninsular Malaysia</i>						
Pahang State	3	0	9	10		
Perak State	2	2	0	4		
Selangor State	1	0	1	2		
Trengganu State	(1)			1		
Total	7	2	10	17	4	18
<i>Sarawak</i>						
Bintulu Division	1	7	2	4		
Miri Division	1	1	0	2		
Semarahan Division	8	1	0	3		
Sri Aman Division	0	0	6	5		
Total	10	9	8	14	4	26
<i>Sabah</i>						
West Coast Residency	0	0	(1)	(1)	(2)*	(1)
Sandakan Residency	0	0	(1)	(1)	(1)	(1)

*see text

category “2” and 52 category “3” records (four, including two from Sabah and two from West Sumatra), were not considered further for evaluation of *Tomistoma* distribution because of problems either of species confirmation or verification of locality. Museum records (category “1”) were usually the earliest published records. All records were from Indonesia (Sumatra, Kalimantan and Java) and Malaysia (Sarawak and Peninsular Malaysia). “Historic” distribution was defined in this study as pre-1940, because the human activities which may have influenced *T. schlegelii* distribution and abundance became much more significant in the 1950s (extensive regional commercial crocodile hunting from the 1950s-70s) (Bezuijen et al., 1997; Simpson et al., 1997) and 1960s (start of large-scale land clearing and development of swamp forest; Barber & Schweithelm, 2000). Geologically, the global distribution of *T. schlegelii* corresponds with that of historic river systems in south-east Asia (Voris, 2000). On

the basis of museum records and geological river systems, the historic distribution of *T. schlegelii* may have encompassed most low lying river systems in Borneo (within Sarawak and Kalimantan), east Sumatra, Java and Peninsular Malaysia.

In Sumatra, records and interviews with local people (Bezuijen et al., 1995, 1997) indicate that *T. schlegelii* was historically widely distributed in eastern Sumatra, from south-east Aceh to Lampung Provinces, and was absent from western Sumatra (even though there are some recent second hand reports from that region, these have not been verified) (Fig. 1). Possible reasons for the absence of *T. schlegelii* from western Sumatra include the existence of extensive mountain ranges dividing west and east Sumatra, which may have stopped westward expansion; a lack of swamp forest habitats in most of western Sumatra; and the lack of physical

connections between the rivers of western Sumatra with the Great Sunda River (Voris, 2000). In Borneo, rivers in western Kalimantan originally formed tributaries of the North Sunda River, while those of southern and eastern Kalimantan were part of a south-eastern drainage flowing towards the Arafura Sea (Hanebuth et al., 2000; Voris, 2000). Rivers in the northeastern regions of East Kalimantan Province and eastern Sabah were not connected to either of the latter river systems, which drained vast lowland (and perhaps swampy) terrain. *Tomistoma schlegelii* was probably widespread in Kalimantan during the Pleistocene (<1 million years ago), and has been reported by local people in the far uppermost parts of the Sg Barito north of Muara Teweh in Central Kalimantan (Stuebing, et al., 2003). In Sarawak, most records are from swampy upstream areas of the Sadong and (Batang) Lupar

Rivers, with many records from western and a few from central areas of the State (Fig. 1).

Current distribution

A total of 180 *T. schlegelii* records were compiled for the period 1980 – 2003. The current range of *T. schlegelii* comprises regions of Borneo (Sarawak, central, west and east Kalimantan), Sumatra and Pensinsular Malaysia. Brief regional summaries on current *T. schlegelii* is given below.

Sumatra (Indonesia)

Confirmed (e.g. categories 1 & 2) records are from lowland, coastal regions of eastern Sumatra, in Riau (10 records), Jambi (21) and South Sumatra (61) Provinces (Table 1; Appendix 1). The western limits of *T. schlegelii* distribution are probably

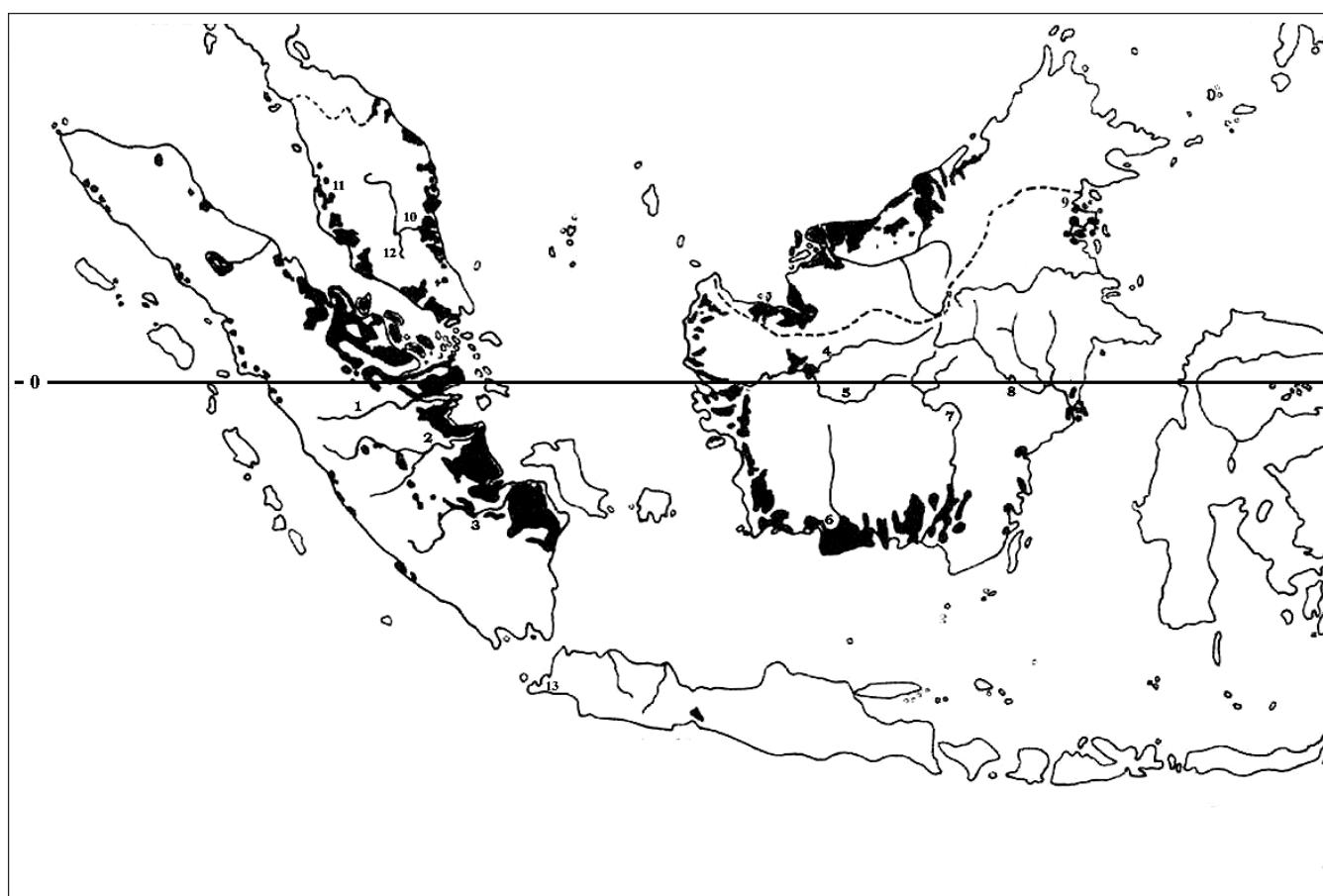


Fig 1. Historical peat swamp distribution in Southeast Asia (after Andriessse, 1974).

Legend (for Fig. 1 only)

- | | | |
|--------|---------|------|
| BORNEO | SUMATRA | JAVA |
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |
| 11. | | |
| 12. | | |
| 13. | | |
- 1. Kampar River
 - 2. Sg Batanghari complex
 - 3. Sg Lalan complex
 - 4. Sg Melawai
 - 5. Sg Kapuas
 - 6. Sg Sekunyir
 - 7. Sg Barito
 - 8. Sg Mahakam (& Mahakam lakes complex)
 - 9. Sg Sebuku
 - 10. Sg Pahang
 - 11. Sg Bera (& Tasek Bera wetland)
 - 12. Sg Perak – Sg Bernam area
 - 13. Ujung Kulon

the foothills of the Barisan mountains, where unconfirmed reports were recorded (Bezuijen et al., 1997). Photographs of *T. schlegelii* eggs and hatchlings said to originate from western Riau Province were shown to one of the authors (MB) in 2002. The most recent confirmed records (2002) are from the Merang River (South Sumatra Province) and Berbak National Park (Jambi Province) (Bezuijen et al., 2002a, b). There are three *T. schlegelii* records since 1980 in Lampung Province, and no records from North Sumatra and Aceh Provinces since 1980, although local reports indicate the species may historically have been widespread in some parts of these provinces (Bezuijen et al., 1997). In Lampung Province, of 13 reported sightings since the 1980s, only one report was of a nest (Bezuijen et al., 1997). Surveys in the largest remaining protected lowland forest in eastern Lampung Province provided no evidence of current occurrence of *T. schlegelii* (Bezuijen et al., 2002a, b). In Sumatra, Riau, Jambi and South Sumatra Provinces are the strongholds for *T. schlegelii*, and the species is now probably rare or locally extinct in many regions of Lampung, North Sumatra and Aceh Provinces.

Borneo (Kalimantan, Sarawak, Sabah)

Confirmed (categories 1 & 2) records are from the lowlands of western and west-central Sarawak (19 records) and West, South, Central and East Kalimantan (28 records) (Table 1). Records in Kalimantan are from a large geographic area, from western Kalimantan, south to Gunung Palung and Tanjung Puting National Parks, and north to Muara Teweh in the upper Barito/Mahakam Rivers, the Mahakam Lakes and eastern part

Central and West Kalimantan (Table 1; Appendix 1). In South Kalimantan Province, extensive loss of swamps due to rice and plantation agriculture has probably eliminated any historic *T. schlegelii* populations. There are no confirmed records from Sabah, where northward extension from Kalimantan may have been constrained by the replacement of slow, swampy waterways with shorter, swift-flowing rivers. Unconfirmed reports of *T. schlegelii* occur from the Sebu River (East Kalimantan Province) and Klias and Kinabatangan Rivers (Sabah) (Appendix 1).

Kalimantan. In West Kalimantan Province, *T. schlegelii* records are from the southern, central and northern regions of the province (Galdikas & Yeager, 1984; Yeager, 1991; Simpson, 2004). Confirmed records are from Gunung Palung, Danau Sentarum and Betung-Kerihun National Parks, with scattered reports from other locations in the province (Bezuijen et al., 2004). In South Kalimantan Province, there is one confirmed record (a museum specimen from the “Banjarmasin” area, De Rooij, 1917). This specimen was probably collected north of Banjarmasin town, which is located in tidal habitat rarely occupied by *T. schlegelii*. In Central Kalimantan Province, the most recent confirmed record of *T. schlegelii* is in the Simpang Kanan and Kuma Rivers in/near Tanjung Puting National Park (Simpson, 2004). In addition, the type specimen for the species was “Lake Lamoeda, southern Kalimantan” (Müller, 1838), which was probably in the Dusun River (a tributary of the Barito River) near Muara Teweh town (M. Hoogmoed, pers. comm.). In East Kalimantan Province, confirmed records indicate *T.*

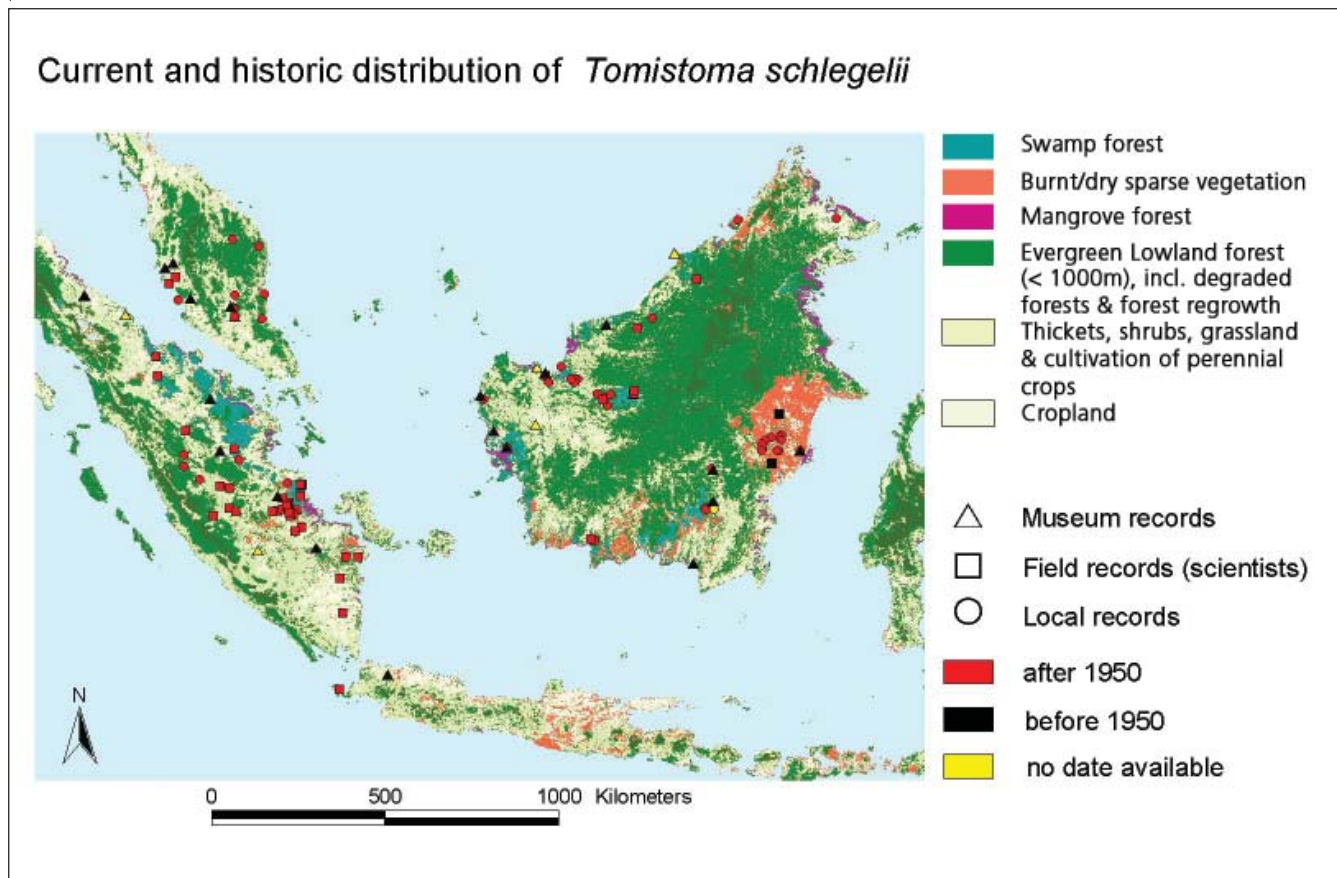


Fig 2. Current forested habitats remaining in the known range of *Tomistoma*, with some important locality records indicated.

schlegelii occur in large sections of the middle Barito River, Mahakam River and the Mahakam Lakes (Appendix 1; Ross et al., 1996). Unconfirmed reports are from the Pari River (Stuebing, et al., 2003; B. Simpson, 2003 pers. comm.) and Sebuku River (KSDA Forest Ranger, 2003 pers. comm.).

Sarawak. Historic accounts give contrasting reports of *T. schlegelii* abundance, variously described as “quite common” in Borneo (Müller and Schlegel, 1845), but much less common than *C. porosus* (Hornaday, 1885), or very locally distributed. Shelford (1916) viewed its distribution as “local”, and that the species seemed abundant only in the Sadong River (a river just east of Kuching in western Sarawak) with few specimens having been taken elsewhere in Sarawak. Most museum specimens, field records and approximately 25 individuals currently in the Jong Crocodile Farm, Kuching, were obtained or are the offspring of animals taken from the upstream tributaries of the Sadong and Batang Lupar Rivers (Appendix 1). Other confirmed records are from the Mayeng, Sarang and Penyilam Rivers (Lading & Stuebing, 1997; Stuebing, et al, 1998, 2004) and Loagun Bunut lake (K. Jensen, 2004, pers. comm.). There are few confirmed records from northern Sarawak, except for a record from the Baram River (B. Simpson, pers. comm.). A crocodile farm owner in Miri, near the Baram River, declared in 2003 that several *T. schlegelii* at his farm were obtained from Kalimantan, but this could not be verified.

Brunei Darussalam. Until April, 2005, there were no confirmed records from Brunei Darussalam, although there were some anecdotal reports of its existence from this geographical area¹. On 12 April 2005, one of us (RBS) visited Bandar Seri Begawan, and was shown a clear photograph of a subadult *Tomistoma schlegelii* obtained from the Tutong River in late 2002.

Sabah. There are no confirmed records from Sabah. No *T. schlegelii* were recorded during crocodile surveys by Whitaker (1984) or R. Stuebing (unpubl. data, June-July 2002, from surveys in the Klias River, Sabah). Local residents in the upper Klias River reported seeing a crocodile resembling a *T. schlegelii* in April 2002, and a second-hand sighting was reported by a tourist in the Kinabatangan River (RBS unpubl. data). These records were not considered suitable for inclusion in the discussion due to vagueness of the reports.

Java (Indonesia)

The current status of *T. schlegelii* in Java is unclear. The species was reported to occur in Java by Klein (1863), on the basis of a crocodile skull described as “*Rhamphostoma Schlegelii* (*Crocodylus Schlegelii* Müller and Schlegel)”, although apparently the locality data have been lost (Auliya, 2003). This report was later cited by Strauch (1866) and De Rooij (1917), although Koningsberger (1913) and Mohr (1921) noted there were no confirmed records of occurrence on the island and that further information was required. Iskandar (2001) does not record this species as confirmed in Java. Local reports correctly describing this species were collected from Ujung Kulon National Park (western Java) in 2002 (Auliya, 2002a, b, 2003), although no direct sightings

were made during surveys. The species was listed in the Park’s fauna by Blower and Zon (1977) and Clarbrough (1990), although it was not mentioned by Hoogerwerf (1970) in a detailed description of the Park’s crocodilian fauna. Based on land connections between Sumatra and Java during the Pleistocene (<1 million years ago; Voris, 2000), it is possible that the species was found on the western portion of the island. Most of Java’s natural habitats are now altered or destroyed, and any remnant population in Ujung Kulon National Park is probably small and isolated.

Peninsular Malaysia

All (category 1-3) *T. schlegelii* records originate from the central interior and western coast of Peninsular Malaysia, including an unconfirmed record from the Sg Jelud in northern Perak State (that was not included in Appendix 1; Sukumaran, 2002). There are four museum specimens for the species from 1896-1940 in the Perak and Selangor States, and all subsequent records are from the Tasek Bera region in the central and eastern parts of Pahang State (Appendix 1). Simpson et al. (1997, 1998) reported that based on local reports, *T. schlegelii* was present in Tasek Bera in the central and western parts of Pahang State, Peninsular Malaysia in 1998, but the team was unable to confirm this despite two weeks of intensive surveys over much of the area.

In the Bahau district Negri Sembilan, during the early years (1950-1970’s) *T. schlegelii* was quite common in Sg Triang and Sg Pertang that adjoin the main Pahang river. At least three specimens of *T. schlegelii* were collected by hunters in these rivers for food (B.L. Lim, pers. comm.). The latest was a large specimen caught in the Sg Triang - Sg Pertang area by hunters in Oct 1999, and picked up by animal dealers (LBL witnessed the specimen). A relative of LBL in Bahau confirmed that at least one more *Tomistoma schlegelii* was caught in September 2002 and was sold to a restaurant in Bahau.

In 2003, two *T. schlegelii* were captured in Perak State: a large male from the Sg Sungkai (near the town of the same name) a tributary of the Sg Perak, and a subadult from the Sg Erung (Appendix 1). There are also local reports of *T. schlegelii* from the Sg Kinta, another tributary of the Sg Perak, just south (downstream) of the 1894 Pulau Tiga locality. Residents of this area maintain that *Tomistoma* can still be found there (Ahmad Darubi, pers. comm.).

Thailand

The status, and even the presence of *T. schlegelii* in Thailand is unclear. One museum specimen is known (UKNHM specimen no. 157993), whose label states “collected in Thailand”, but with no other supporting information provided (this record was not included in the database). There are unconfirmed reports of *T. schlegelii* from Hala-Bala Wildlife Sanctuary and Kaeng Krachan National Park (P. P. van Dijk, 2003 pers. comm.). Some local crocodile farms have many *T. schlegelii* but the origin of these animals could not be determined. Smith (1916) lists *T. schlegelii* as occurring in the “Inland Sea (Peninsular Siam)” (Thailand), but gives no further data, yet Chan-ard et. al. (1999) did not list *T. schlegelii* as occurring in Thailand. It is possible that *T. schlegelii* did

not historically occur in Thailand, unless northern areas previously under Thai sovereignty (now the Malaysian States of Kedah and Perlis) are included.

Vietnam

In the January-March 2005 issue of its Newsletter, the IUCN/SSC Crocodile Specialist Group carried a letter from Mr. J. Mucelli, who stated that he had witnessed the killing of a *Tomistoma schlegelii* by South Vietnamese soldiers in 1967, "in the vicinity of Dai Quay bridge, Lam Dong Province" (along highway 20, the Ho Chi Minh City (formerly Saigon) to Dalat road). This is the first and only report of the species (that we are aware of) from Vietnam, and requires further investigation. The author of the article was convinced that the species did once inhabit the area, a "lowland forest with large tracts of bamboo" (Mucelli, 2005).

DISCUSSION

Geologic and current distribution

Tomistoma-like crocodylians were widely distributed in the Americas, Europe, Africa and Asia from the beginning of the Tertiary to the Miocene (approximately 60-30 mya), and are well-represented in the fossil record. In north and east Asia, at least one genus of *Tomistoma*-like crocodylian, *Tomistomine*, occurred until the Pliocene or early Pleistocene (C. Brochu, 2003). More recently, the fossil distribution of *Tomistoma* may have included southern China, where subfossil remains of a *Tomistoma* crocodylian were reported, apparently dating from 1,300-1,400 CE (Ross et al., 1996). *Tomistomines*, whose fossil record is far more obscure, occurred in Japan and Taiwan as late as the Pliocene or early Pleistocene, but their range appears to have progressively contracted as the climate appropriate for them deteriorated, resulting in their present distribution (Steel, 1989).

Pleistocene maps of the Sunda region showing the outline of major river systems in Peninsular Malaysia, Sumatra, Java and Borneo (Voris, 2000) do indicate that *T. schlegelii* probably occupied a greater range than it does today. The vast interlinked river systems of the Sunda region (Great Sunda River basin) were undoubtedly associated with some peat swamp habitats (long since submerged by rising seas). This ecological scenario would imply that *T. schlegelii* could have been distributed broadly throughout ancient Sundaland, from northern and eastern Sumatra and adjacent parts of Peninsular Malaysia, southwards to western Java and eastwards into large areas of Borneo. Nearly all records examined in this paper can be seen to lie within the geologic watersheds of several ancient and low-lying river systems depicted in Voris (2000). Western Borneo and south-central Sumatra seem to form one biogeographical region (Yap, 2002), where the majority of False Gharial records are located. Outlier records, most of which are unconfirmed, are from Vietnam, Thailand, extreme East Kalimantan, northern Sarawak and south-west Sabah.

Compared to its apparent prehistoric range, the current distribution of the False Gharial seems to have become more fragmented, though this can only be surmised, given the

dearth of good records, both fossil and recent (especially in view of the difficulty in conducting effective surveys). Approximately 95% of the current geographic distribution of *T. schlegelii* appears to be confined to a region about five degrees north and south of the equator. Recent records do seem to cluster within one degree of the equator, but this may be an artefact of increased survey effort in specific regions, such as in the Danau Sentarum and the Mahakam Lakes. The overall presence for the species seems rather widely scattered over the ten degree latitudinal band. Kalimantan and Sarawak are considered to potentially support the largest global populations of *T. schlegelii*, on the basis of land mass and large remnants of potential swamp forest nesting and foraging habitat.

In Sumatra, the species may now be rare or absent from regions of the north-east and south-east of the island, i.e. Lampung, Aceh and North Sumatra Provinces. These areas may have historically supported smaller regions of swamp forest than the central-eastern provinces of Riau, Jambi and South Sumatra. It is likely that habitat loss has contributed to this apparent range decline. In Lampung Province, the most intensively developed and populated of Sumatran provinces, large-scale habitat loss and disturbance has occurred in sites where local people formerly reported sightings and nesting (Bezuijen et al., 1997, 2002a). Similarly, much of eastern Sumatra has been subjected to land clearing or burning (Barber and Schweithelm, 2000; Bezuijen et al., 2001a, b). Local people interviewed in eastern Sumatra reported that *T. schlegelii* was previously "common" or "often seen" 20 years ago, but had declined over the last 15-20 years, particularly in areas which had been burnt (Bezuijen et al., 1995, 1997). It is possible that *T. schlegelii* populations are reduced or absent from a substantial number of the river systems of eastern Sumatra.

In Peninsular Malaysia, scattered populations of *T. schlegelii* still exist, and small numbers are seen in any given year in Perak State and possibly also in Pahang State. Historic centres of distribution included Pahang, Perak and Selangor States. These sites, however, have been seriously disturbed by tin mining, the opening of rubber and oil palm plantations, and urban development. Furthermore, Malaysia's human population has nearly doubled since 1970, and currently exceeds 25 million inhabitants (Government of Malaysia, 2004). Given the limited land area and increasing development in the peninsular, it seems likely the populations of *T. schlegelii* have declined significantly, becoming rare, or absent in many waterways where they formerly occurred.

Habitat

Peat swamps apparently made up 12% of the area of Sarawak (about 14,500km²) and about 22.6% of Brunei (Anderson, 1964). Sabah's peat swamp and kerangas habitats are limited to a small corner in its extreme southwest in a triangle between the towns of Membakut, Beaufort and Kuala Penyu encompassing an insignificant portion of the land area of that state. Peat swamps cover significant areas of the western and southern Kalimantan, southeastern Sumatra and a band in Peninsular Malaysia running from central Perak, to Malacca,

and although interrupted by the Main Range, eastwards from Negeri Sembilan and the upper Sg Pahang drainage to extensive coastal areas south of the town of Kuantan (Fig. 2). Over the last 35 years, oceanographers have found peat swamp remnants in cores taken from sites as disparate as the Malacca Straits, off the coast of Singapore, off the east coast of Peninsular Malaysia and along an extensive NE/SW transect in the South China Sea (Inger et al., 2005). In both Sumatra and Borneo, peat swamps extend well inland from coastal areas, and are found as far inland as the Sg Penyilam and Loagan Bunut in Sarawak, and the Sg Maruwai in the extreme northern portion of Central Kalimantan Province (Stuebing, et al., 2003). Based on carbon-14 dates from the above peat cores, the age of the Sunda region peat swamps ranges from approximately 44,200 - 3530 yBP, corresponding to a period of large fluctuations in the level the South China Sea during the last temperate-zone glaciation (Anderson, 1964; Geyh et al., 1979; Hesp et al., 1998; Hanebuth et al., 2000).

The geographical records for *T. schlegelii* are associated with low lying areas such as peat swamps, freshwater swamps and flood plains. It is clear from the location of most records of *T. schlegelii*, that the species seems to favor that habitat (Fig. 2). Most museum or field records of *T. schlegelii* nests are from peat swamp or freshwater swamp forest, and the species has generally been regarded as a peat swamp specialist (Bezuijen et al., 1998, 2001a; Ross et al., 1998). Müller and Schlegel (1845) described the species habitat as “quiet/isolated and calm water bodies, from which it occasionally visits slow-moving tributaries and swamps with black smelly water. ... it rarely enters rivers with strong currents.” Surveys by the authors and interviews with local people in range states have consistently reported similar habitats for this species. Unfortunately, the wide variation in the manner in which these data have been collected precludes a more systematic analysis than has been possible for this paper.

Although peat swamp forest appears to be the preferred habitat of this species, *Tomistorna* has also been recorded from other lowland forest habitats, e.g. impounded water catchments in Peninsular Malaysia (Chan-Ard et al., 1999), freshwater swamp forests in central Sarawak (R. Stuebing, photographic evidence from Bukit Sarang in Ulu Kakus/Tatau; see Appendix) and the Sg Sibau in West Kalimantan (Bezuijen et al., 2004).

Abundance

Effective assessment of *T. schlegelii* abundance is hindered by its cryptic coloration and its secretive nature. Spotlight surveys in areas where *T. schlegelii* are known to occur, frequently do not result in sightings (authors pers. obs. in Sumatra, Kalimantan, Sarawak). Ross et al. (1996) noted that in many areas of Kalimantan, the species was regarded as the “common” crocodylian compared with *Crocodylus* species. The species appears to be abundant in some rivers close to Tanjung Puting National Park in Central Kalimantan Province (Simpson, 2004). The difficulty in assessing the local status of the species is illustrated by its recent “rediscovery” in Ujung Kulon National Park in western Java

(Auliya, 2002a, b, 2003), a highly visited and surveyed region. Confirmed records (in 2003) of individuals in Perak State and Kenyir Lake (Terengganu State) in Peninsular Malaysia indicate that at least some individuals continue to survive and breed, even in relatively developed areas. In general, these records indicate the species may remain widespread, but in reduced densities, in many areas where it was formerly abundant. In reality, however, there are few areas, perhaps with the exception of Tanjung Puting National Park in southern Kalimantan (Central Kalimantan Province) where it can be stated with any confidence that *T. schlegelii* is actually “abundant”. Until more effective survey approaches and techniques can be developed, any assertions on abundance or rarity will remain of questionable value, for all but the most obviously altered habitats.

Threats and conservation priorities

Key anthropogenic threats to the long-term survival of *T. schlegelii* include regional loss of nesting habitat due to forest fires, incidental or commercial harvest for food, illegal logging or the development of industrial tree plantations, peat swamp clearance and drainage for irrigated agriculture, oil and gas exploitation in swamp forests, uncontrolled regional settlement of swamp forests, and also incidental mortality of breeding individuals in fishing nets (Bezuijen et al., 2002a, 2004; Frazier, 2000). Small, fragmented and isolated populations (particularly those in Peninsular Malaysia, where most regions are subject to intensive development) are probably vulnerable to demographic or environmental stochasticity, and may eventually become locally extinct due to a lack of suitable nesting habitat or disturbance. In Sarawak, peat swamp tributaries of the Sg Sadong, including the Sg Ensengai, where *T. schlegelii* was formerly known to be reasonably abundant in the early 1980s (Cox and Gombek, 1985), have now been drained or the main waterway “straightened” with a permanent drainage system (J. Jong, pers. comm.). Based on the records and mapping conducted for this paper, *T. schlegelii* still appears to occupy large parts of its global distribution, although many populations are probably at substantial risk from the threats given above. From this data, it appears that although insufficient population data is available to confidently assess whether the IUCN “Endangered” status of the species as is warranted, “Critically Endangered” status is at least, unlikely.

Conservation activities of high-priority for this species were identified by Bezuijen et al. (2003), and include baseline surveys in specific regions of eastern Sumatra, Borneo and Peninsular Malaysia, as well as the implementation of population monitoring programs in three sites for which there are repeat surveys: the Sg Merang and Berbak National Park (eastern Sumatra) and Tanjung Puting National Park (central Kalimantan). In this review, we add the following sites to that list for baseline surveys: Sg Sibau and Gunung Palung National Park (West Kalimantan), and also the Lingga-Simunjan area and Maludam Wildlife Sanctuary in Sarawak. To assist in the objective prioritisation of these areas, a simple scoring system to prioritise each area is recommended, based on the following criteria: A) whether *T. schlegelii* appears to be abundant in a site; B) the site supports suitable nesting

and foraging habitat (based on field records, etc); C) the site's potential for effective protection and management. Individual sites would be classified as "high priority" for conservation (scoring in all three categories), "medium priority" (a site with only two of these variables), or "low priority" (a site supporting only variable). Identification and classification of sites could begin by examining geological maps in the main areas of abundance (Sumatra and Borneo) to identify old, low lying alluvial basins that contain peat swamp remnants or flooded "blackwater" forests where the species seems to reside within some fairly distinct vertebrate communities (Inger et al., 2005).

Current centres of distribution

Current strongholds for the species are few, but some remain in several (restricted) regions of Borneo, including Central, East and West Kalimantan Provinces, in western Sarawak and in central and eastern Sumatra. The species appears to be relatively abundant (although difficult to detect) in some sites in southern Borneo (such as Tanjung Puting National Park in Central Kalimantan), while in other regions in Borneo and Sumatra its abundance may be underestimated. In areas where the species appears to have declined or become rare (north-eastern and south-eastern Sumatra, Peninsular Malaysia), this decline appears to have occurred relatively recently, i.e. within the last 30-40 years. Local people along lowland forested waterways in eastern Sumatra report the species to be 'common', but believe it has declined in the last 20 years (Bezuijen, et al. 1997, 1998), because of extensive habitat loss, including regional forest fires such as in the 1990s (Barber and Schweithelm, 2000).

ACKNOWLEDGMENTS

We thank the following personnel and institutions for providing information on *T. schlegelii* specimens held in their collections (full names of institutions are given in Appendix 1): W. Böhme (ZFMK); J. Boundy (LDWF); N. Gilmore (ANSP); Hamburg Museum; J. Hanken (MCZ); M. Hoogmoed (NNM); B. Lardner (NHM); K. Lim (RMBR); U. Manthey (for Senckenberg and Berlin Museums); J. Rosado (MCZ); C. McCarthy (BMNH); A. Schmitz (MDH); G. Schneider (UMMZ); J.E. Simmons (UKNHM); A. Snider (DZ); K. Tighe (USNM); J. Vindum (CAS); K. Zyskowski (PM); H.-J. Stibig (GVM, Global Vegetation Monitoring Unit, Italy); R. Melisch (WWF Germany); GIS Unit (ZFMK). We also thank the following persons for providing field records or other contributions in the field towards compilation of this records: Aman; Jasmi Abdul; C. Brochu; A. Darubi; I. Das; V. Dinets; Eddie; A. Etin; R. F. Inger; Z. A. Jaafar; K. Jensen; J. Jong; D. M. N Khalid; A. Kong; E. Lading; K. Lazarus; W. Landong; B. L. Lim; A. Long; G. MacNair; S. C. Manolis; A. Resetar; S. A. M. Sah; B. Simpson. Professor G. J. W. Webb and two anonymous reviewers gave critical comments on a draft manuscript. This study was partially funded by an award from the Field Museum of Natural History Bass Fund for Visiting Scholars, for which the authors are grateful.

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CAS California Academy of Sciences, Berkeley

DZ Detroit Zoo

HM Hamburg Museum

FMNH Florida Museum of Natural History, University of Florida, Gainesville

LSUMZ Museum of Vertebrate Zoology, Louisiana State University, Baton Rouge

MCZ Museum of Comparative Zoology, Harvard University

MDH Museum d'histoire naturelle, Genève

NNM Nationaal Natuurhistorisch Museum Leiden

NRM Naturhistoriska Riksmuséet, Stockholm

PM Peabody Museum, Yale University, New Haven

RMBR Raffles Museum of Biodiversity Research, National University of Singapore

SMF Senckenberg Museum

UKNHM University of Kansas Natural History Museum (Kansas, USA)

UMMZ University of Michigan Museum of Zoology

USNM National Museum of Natural History, Smithsonian Institution, Wash. D.C.

ZFMK Zoologische Forschungsinstitut & Museum Alexander Koenig, Bonn

ZMB Zoologische Museum, Berlin

APPENDIX 1

Appendix 1. A gazetteer of localities for *Tomistoma schlegelii* based on museum specimens, field observations and local reports.

Key (for appendix 1 only)

ANSP Academy of Natural Sciences, Philadelphia

BMNH British Museum of Natural History, London

Record	Country	Region	Political unit	Locality	Latitude / Longitude	Category	Date	Source	Notes
1	Indonesia	Java	Banten Province	Ujung Kulon NP	6°40'00"S 105°20'30"E	2	2002	Auliya, 2002a, b	Seen at Nyiur Swamp
2	Indonesia	Java	West Java Province	Batavia (= Jakarta)	06°S 105°E	1	1937	NMNH, 1937	Collector: unknown.
3	Indonesia	Kalimantan	Central Kalimantan Province	Sg Dusun	1°48'S 105°04'E	1	1838	Müller 1838	Type specimen. Near Muara Teweh
4	Indonesia	Kalimantan	Central Kalimantan Province	Sg Sekonyer	2°50'00"S 111°55'00"E	2	2002	Simpson, 2004	near Simpan Kanan Creek
5	Indonesia	Kalimantan	Central Kalimantan Province	Sg Sekonyer	2°50'00"S 111°55'00"E	2	2002	Simpson, 2004	near Simpan Kanan Creek
6	Indonesia	Kalimantan	Central Kalimantan Province	Sg Sekonyer	2°50'00"S 111°55'00"E	2	2002	Simpson, 2004	near Simpan Kanan Creek
7	Indonesia	Kalimantan	Central Kalimantan Province	Sg Sekonyer	2°50'00"S 111°55'00"E	2	2002	Simpson, 2004	near Simpan Kanan Creek
8	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
9	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
10	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
11	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
12	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
13	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
14	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
15	Indonesia	Kalimantan	Central Kalimantan Province	Sg Simpan Kanan (Tanjung Puting NP)	2°47'00"S 111°50'00"E	2	2002	Simpson, 2004	Camp Leakey as mapping point
16	Indonesia	Kalimantan	Central Kalimantan Province	Tanjung Puting NP	4°30'S 116°40'E	1	1991	Yeager, 1991	Camp Leakey as mapping point
17	Indonesia	Kalimantan	East Kalimantan Province	Alan Creek	0°51'S 116°31'E	2	1925	Witkamp, 1925	"Alan" Creek, Mahakam
18	Indonesia	Kalimantan	East Kalimantan Province	Danau Belbis Lake / Sg Bongon	0°27'21"S 116°17'04"E	3	1996	Ross et al., 1996	
19	Indonesia	Kalimantan	East Kalimantan Province	Danau Belbis Lake / Sg Bongon	0°27'21"S 116°17'04"E	3	1994	Muin & Ramono, 1994	
20	Indonesia	Kalimantan	East Kalimantan Province	Danau Anggelam	0°15'00"S 116°19'58"E	3	1996	Ross et al., 1996	
21	Indonesia	Kalimantan	East Kalimantan Province	Danau Lamuda	approx 1°S 115°E	1	1917	De Rooij, 1917	Collector: N. De Rooij
22	Indonesia	Kalimantan	East Kalimantan Province	Danau Mesangat	0°31'06"S 116°41'47"	3	1996	Ross et al., 1996	
23	Indonesia	Kalimantan	East Kalimantan Province	Danau Semang (Meliau)	0°55'48"S 112°21'08"E	3	1996	Ross et al., 1996	
24	Indonesia	Kalimantan	East Kalimantan Province	Danau Tebrau	0°14'29"S 116°46'00"E	3	1996	Ross et al., 1996	
25	Indonesia	Kalimantan	East Kalimantan Province	Danau Tempatang	0°30'S 116°15'E	3	1994	Muin & Ramono, 1994	
26	Indonesia	Kalimantan	East Kalimantan Province	Lahe	0°58'S 114°57'E	3	1996	Ross et al., 1996	Along Barito River
27	Indonesia	Kalimantan	East Kalimantan Province	Muara Kaman	0°09'28"S 116°42'49"E	3	1996	Ross et al., 1996	
28	Indonesia	Kalimantan	East Kalimantan Province	Muara Kaman	0°09'28"S 116°42'49"E	3	1994	Muin & Ramono, 1994	Along Mahakam River
29	Indonesia	Kalimantan	East Kalimantan Province	Sg Batampang	1°59'35"S 114°47'50"E	3	1996	Ross et al., 1996	
30	Indonesia	Kalimantan	East Kalimantan Province	Sg Batilap	2°02'16"S 114°48'32"E	3	1996	Ross et al., 1996	
31	Indonesia	Kalimantan	East Kalimantan Province	Sg Belayan	0°10'S 116°30'E	3	1994	Muin & Ramono, 1994	Tributary of Mahakam River?
32	Indonesia	Kalimantan	East Kalimantan Province	Sg Kahata	0°20'S 116°15'E	3	1994	Muin & Ramono, 1994	
33	Indonesia	Kalimantan	East Kalimantan Province	Sg Leboyan	0°52'00"N 112°13'00"E	3	1996	Ross et al., 1996	
34	Indonesia	Kalimantan	East Kalimantan Province	Sg Liang Buaya	0°05'52"S 116°45'27"E	3	1996	Ross et al., 1996	
35	Indonesia	Kalimantan	East Kalimantan Province	Sg Mahakam	0°30'S 117°15'E	3	1996	Ross et al., 1996	
36	Indonesia	Kalimantan	East Kalimantan Province	Sg Seutlang	0°30'S 116°40'E	3	1996	Ross et al., 1996	
37	Indonesia	Kalimantan	East Kalimantan Province	Sg Telen	0°26'N 116°42'E	2	1927	Endert, 1927	Nest with eggs. Sg Telen, E. Kalimantan
38	Indonesia	Kalimantan	South Kalimantan Province	Banjarmasin	3°25'S 114°30'E	1	1917	De Rooij, 1917	Collector: N. De Rooij
39	Indonesia	Kalimantan	West Kalimantan Province	Danau Sentanum NP	0°58'S 112°00'E	3	1994	Frazier, 2000	W. Giessen in litt. to Frazier (2000)
40	Indonesia	Kalimantan	West Kalimantan Province	Danau Sentanum NP	0°58'S 112°00'E	3	1996	Ross et al., 1996	
41	Indonesia	Kalimantan	West Kalimantan Province	Pontianak town	0°00'S 109°20'E	1		SMF	Collector: Schlegel?
42	Indonesia	Kalimantan	West Kalimantan Province	Pontianak	0°00'S 109°20'E	1	1917	De Rooij, 1917	Collector: N. De Rooij
43	Indonesia	Kalimantan	West Kalimantan Province	Samarinda	0°30'S 117°15'E	1	1915	NMNH, 1915	Collector: H.C. Raven.
44	Indonesia	Kalimantan	West Kalimantan Province	Sanggau (Kapuas)	0°10'N 110°25'E	1		NMNH	Collector: W.L. Abbot
45	Indonesia	Kalimantan	West Kalimantan Province	Sg Jongkong	0°39'53"S 112°17'08"E	3	1996	Ross et al., 1996	

Record	Country	Region	Political unit	Locality	Latitude / Longitude	Category	Date	Source	Notes
46	Indonesia	Kalimantan	West Kalimantan Province	Sg Kapuas	0°25'S 109°40'E	1	1917	De Rooij, 1917	Collector: N. De Rooij
47	Indonesia	Kalimantan	West Kalimantan Province	Sg Kapuas	0°25'S 109°40'E	3	1996	Ross et al., 1996	
48	Indonesia	Kalimantan	West Kalimantan Province	Sg Sekolat	0°48'00"S 112°09'00"E	2	1996	Ross et al., 1996	
49	Indonesia	Kalimantan	West Kalimantan Province	Sg Sibau	0°58'N 112°57'E	1	1995	Auliya, 2000; ZFMK 66591	near Tanjung Lhasa
50	Indonesia	Kalimantan	West Kalimantan Province	Sg Tempuran	0°49'N 119°05'E	3	1996	Ross et al., 1996	
51	Indonesia	Kalimantan	West Kalimantan Province	Singkawang	0°55'N 119°00'E	1	1917	De Rooij, 1917	Collector: N. De Rooij, near Sg Sambas
52	Indonesia	Kalimantan	West Kalimantan Province	Sg Sibau	0°58'N 112°57'E	2	1996	Auliya, 2000	Above Tanjung Lhasa
53	Indonesia	Kalimantan	West Kalimantan Province	Sg Sibau	1°02'N 112°58'E	2	2003	Zulkifli & Albertus, 2003	
54	Indonesia	Sumatra	Jambi Province	Jambi	1°40'S 103°45'E	1	1905	RMBR, 1905	Collector: unknown? - ROB?
55	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Dalam	1°20'20"S 104°00'30"E	3	2001	Bezuijen et al., 2001a, b	
56	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Dalam	1°20'20"S 104°00'30"E	3	2001	Bezuijen et al., 2001a, b	
57	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Laut	1°22'55.1"S 104°23'04.7"E	2	1996	Bezuijen et al., 1997	
58	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Laut	1°23'43.5"S 104°22'03.6"E	2	1996	Bezuijen et al., 1997	
59	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Laut	1°23'49.0"S 104°22'03.7"E	2	2001	Bezuijen et al., 2001	
60	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Laut	1°23'49.0"S 104°22'03.7"E	2	1990	J. Cox unpubl. data, 1990	
61	Indonesia	Sumatra	Jambi Province	Sg Air Hitam Laut	1°25'37.2"S 104°20'47.2"E	2	2002	Bezuijen et al., 2002	
62	Indonesia	Sumatra	Jambi Province	Sg Alai	1°25'S 102°15'E	2	1996	Bezuijen et al., 1997	Captive specimen
63	Indonesia	Sumatra	Jambi Province	Sg Alai	1°25'S 102°15'E	2	1996	Bezuijen et al., 1997	
64	Indonesia	Sumatra	Jambi Province	Sg Alai	1°25'S 102°15'E	2	1994	Bezuijen et al., 1997	Nest
65	Indonesia	Sumatra	Jambi Province	Sg Alai	1°25'S 102°15'E	2	1997	Bezuijen et al., 1997	
66	Indonesia	Sumatra	Jambi Province	Sg Batang Hari	1°28'S 102°30'E	2	1996	Independent Newspaper, 1996	4.1 m indiv. photographed & reported
67	Indonesia	Sumatra	Jambi Province	Sg Belango	2°00'S 102°30'E	2	1995	Bezuijen et al., 1997	
68	Indonesia	Sumatra	Jambi Province	Sg Mentawak	2°05'S 102°40'E	2	1997	Bezuijen et al., 1997	
69	Indonesia	Sumatra	Jambi Province	Sg Mentawak	2°05'S 102°40'E	2	1985	Bezuijen et al., 1997	Nest
70	Indonesia	Sumatra	Jambi Province	Sg Merangin	2°11'S 102°05'E	2	1985	Bezuijen et al., 1997	
71	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°22'52.4"S 104°20'43.3"E	2	2001	Bezuijen et al., 2001a, b	
72	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°22'52.4"S 104°20'43.3"E	2	2001	Bezuijen et al., 2001a, b	
73	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°22'52.4"S 104°20'43.3"E	2	2001	Bezuijen et al., 2001a, b	
74	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°23'41.7"S 104°21'02.3"E	2	2001	Bezuijen et al., 2001a, b	
75	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°23'41.7"S 104°21'02.3"E	2	2001	Bezuijen et al., 2001a, b	
76	Indonesia	Sumatra	Jambi Province	Sg Simpang Melaka	1°22'43.9"S 104°20'46.6"E	2	2002	Bezuijen et al., 2002	
77	Indonesia	Sumatra	Lampung Province	Sg Mesuji	3°48'S 105°22'E	2	1993	Bezuijen et al., 1997	
78	Indonesia	Sumatra	Lampung Province	Sg Mesuji	3°48'S 105°22'E	2	1997	Bezuijen et al., 1997	
79	Indonesia	Sumatra	Lampung Province	Sg Pengbuan	4°42'S 105°25'E	2	1985	Bezuijen et al., 1997	
80	Indonesia	Sumatra	Lampung Province	Sg Pengbuan	4°42'S 105°25'E	3	1980	Bezuijen et al., 1997	
81	Indonesia	Sumatra	North Sumatra Province	Deli (= Medan)	approx. 3°30'S 98°45'E	1	1906	NMNH	Nest
82	Indonesia	Sumatra	North Sumatra Province	Deli (= Medan)	approx. 3°30'S 98°45'E	1	1906	NMNH	Collector: L. P. De Bussy
83	Indonesia	Sumatra	North Sumatra Province	Medan	approx. 3°30'S 98°45'E	1	1906	SMF	Collector: L. P. De Bussy
84	Indonesia	Sumatra	North Sumatra Province	Perbaungan	approx. 3°30'S 98°45'E	1	1906	SMF	Collector: unknown? - ROB?
85	Indonesia	Sumatra	North Sumatra Province	Tanjung Balei	approx. 3°00'N 100°10'E	1	1906	NRM	Collector: unknown? - ROB?
86	Indonesia	Sumatra	Riau Province	Indrapura Estate	approx. 0°50'N 102°00'E	1	1906	HM, 1884/85	Collector: E. Mj'berg
87	Indonesia	Sumatra	Riau Province	Sg Gangsal	0°45'S 102°45'E	3	1996	Bezuijen et al., 1997	Collector: Siemsen
88	Indonesia	Sumatra	Riau Province	Sg Gangsal	0°45'S 102°45'E	3	1996	Bezuijen et al., 1997	
89	Indonesia	Sumatra	Riau Province	Sg Indragiri	approx. 0°30'S 102°15'E	1	1901	NMNH, 1901	Collector: J. Hurter
90	Indonesia	Sumatra	Riau Province	Sg Kubu	1°55'N 100°36'E	2	1996	Bezuijen et al., 1997	

Record	Country	Region	Political unit	Locality	Latitude / Longitude	Category	Date	Source	Notes
91	Indonesia	Sumatra	Riau Province	Sg Kubu	1°55'N 100°36'E	2	1996	Bezuijen et al., 1997	
92	Indonesia	Sumatra	Riau Province	Sg Kubu	1°55'N 100°36'E	3	1996	Bezuijen et al., 1997	
93	Indonesia	Sumatra	Riau Province	Sg Siak	0°37'S 101°19'E	3	1996	Bezuijen et al., 1997	
94	Indonesia	Sumatra	Riau Province	Sg Sibayang-bayang	0°28'S 102°37'E	2	1986	Bezuijen et al., 1997	
95	Indonesia	Sumatra	Riau Province	Sg Teso	0°00'S 101°22'E	2	1996	Bezuijen et al., 1997	
96	Indonesia	Sumatra	Riau Province	Sg Teso	0°00'S 101°22'E	2	1995	Bezuijen et al., 1997	Nest
97	Indonesia	Sumatra	Riau Province	Sg Teso	0°00'S 101°22'E	2	1993	Bezuijen et al., 1997	
98	Indonesia	Sumatra	Riau Province	Sg Teso	0°00'S 101°22'E	2	1985	Bezuijen et al., 1997	Nest
99	Indonesia	Sumatra	Riau Province	Tamah Putih Pujud	1°26'N 100°38'E	2	1995	Bezuijen et al., 1997	
100	Indonesia	Sumatra	South Sumatra Province	Sg Benu	1°40'S 104°21'E	2	1996	Bezuijen et al., 1997	
101	Indonesia	Sumatra	South Sumatra Province	Sg Benu	1°40'S 104°21'E	2	1996	Bezuijen et al., 1997	
102	Indonesia	Sumatra	South Sumatra Province	Sg Benu	1°40'S 104°21'E	2	1996	Bezuijen et al., 1997	
103	Indonesia	Sumatra	South Sumatra Province	Sg Benu	1°40'S 104°21'E	2	1993	Bezuijen et al., 1997	
104	Indonesia	Sumatra	South Sumatra Province	Sg Kephayang	2°02'39"S 104°14'21"E	2	1995	Bezuijen et al., 1997	
105	Indonesia	Sumatra	South Sumatra Province	Sg Lalan	2°10'S 104°05'E	2	1995	Bezuijen et al., 1997	
106	Indonesia	Sumatra	South Sumatra Province	Sg Lalan	2°10'S 104°05'E	2	1995	Bezuijen et al., 1997	
107	Indonesia	Sumatra	South Sumatra Province	Sg Lalan	2°05'S 103°37'E	2	1995	Bezuijen et al., 1997	
108	Indonesia	Sumatra	South Sumatra Province	Sg Lalan	2°04'S 103°45'E	2	1990	J. Cox unpubl. data	
109	Indonesia	Sumatra	South Sumatra Province	Sg Lalan	2°05'S 103°37'E	2		Bezuijen et al., 1995	
110	Indonesia	Sumatra	South Sumatra Province	Sg Lumpur	3°15'S 105°30'E	2	1993	R. Kadarisman pers. comm.	
111	Indonesia	Sumatra	South Sumatra Province	Sg Medak	2°01'20"S 103°52'05"E	2	1995	Bezuijen et al., 1995	
112	Indonesia	Sumatra	South Sumatra Province	Sg Medak	2°01'20"S 103°52'05"E	2	1995	Bezuijen et al., 1995	
113	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°08'38.9"S 104°08'42.9"E	2	1995	Bezuijen et al., 1995	
114	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°06'01.3"S 104°03'52.7"E	2	1995	Bezuijen et al., 1995	
115	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°06'01.3"S 104°03'52.7"E	2	1995	Bezuijen et al., 1995	
116	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°00'07.8"S 104°02'06.7"E	2	1995	Bezuijen et al., 1995	
117	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°00'07.8"S 104°02'06.7"E	2	1995	Bezuijen et al., 1995	
118	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°00'07.8"S 104°02'06.7"E	2	1995	Bezuijen et al., 1995	
119	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°58'49.2"S 104°00'49.4"E	2	1995	Bezuijen et al., 1995	
120	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°58'49.2"S 104°00'49.4"E	2	1995	Bezuijen et al., 1995	
121	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°58'49.2"S 104°00'49.4"E	2	1995	Bezuijen et al., 1995	
122	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°58'49.2"S 104°00'49.4"E	2	1995	Bezuijen et al., 1995	
123	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	1995	Bezuijen et al., 1995	
124	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	1995	Bezuijen et al., 1995	
125	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	1995	Bezuijen et al., 1995	
126	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	1995	Bezuijen et al., 1995	
127	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'07.1"S 104°01'12.7"E	2	1995	Bezuijen et al., 1995	
128	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'07.1"S 104°01'12.7"E	2	1995	Bezuijen et al., 1995	
129	Indonesia	Sumatra	South Sumatra Province	Sg Merang	2°06'01.3"S 104°03'52.7"E	2	1996	Bezuijen et al., 1997	
130	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'37.9"S 103°59'55.3"E	2	1996	Bezuijen et al., 1997	
131	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	1996	Bezuijen et al., 1997	
132	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'07.1"S 104°01'12.7"E	2	1996	Bezuijen et al., 1997	
133	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'07.1"S 104°01'12.7"E	2	1996	Bezuijen et al., 1997	
134	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'07.1"S 104°01'12.7"E	2	1996	Bezuijen et al., 1997	
135	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'56.2"S 104°00'37.9"E	2	2001	Bezuijen et al., 2001a, b	

Record	Country	Region	Political unit	Locality	Latitude / Longitude	Category	Date	Source	Notes
136	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°51'37.7"S 104°00'44.1"E	2	2001	Bezuijen et al., 2001a, b	
137	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°50'43.8"S 104°03'06.2"E	2	2001	Bezuijen et al., 2001a, b	
138	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°50'43.8"S 104°03'06.2"E	2	2001	Bezuijen et al., 2001a, b	
139	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°50'43.8"S 104°03'06.2"E	2	2001	Bezuijen et al., 2001a, b	
140	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°50'43.8"S 104°03'06.2"E	2	2001	Bezuijen et al., 2001a, b	
141	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	2001	Bezuijen et al., 2001a, b	
142	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	2001	Bezuijen et al., 2001a, b	
143	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	2001	Bezuijen et al., 2001a, b	
144	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	2001	Bezuijen et al., 2001a, b	
145	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°53'17.1"S 104°00'12.8"E	2	2001	Bezuijen et al., 2001a, b	
146	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	2001	Bezuijen et al., 2001a, b	
147	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	2001	Bezuijen et al., 2001a, b	
148	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	2001	Bezuijen et al., 2001a, b	
149	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	2001	Bezuijen et al., 2001a, b	
150	Indonesia	Sumatra	South Sumatra Province	Sg Merang	1°55'37.3"S 103°58'54.5"E	2	2001	Bezuijen et al., 2001a, b	
151	Indonesia	Sumatra	South Sumatra Province	Sg Muara Klingi	2°06'S 104°03'E	2	1990	J. Cox unpubl. data	Collector unknown. Locality "near Nimi" (?)
152	Indonesia	Sumatra	South Sumatra Province	Sg Pedada	3°05'S 103°14'E	1	SMF		
153	Indonesia	Sumatra	South Sumatra Province	Sg Pejudian	3°15'S 105°50'E	2	1994	Ramono, 1994	
154	Indonesia	Sumatra	South Sumatra Province	Sg Pejudian	1°44'27"S 103°52'17"E	2	1995	Bezuijen et al., 1995	
155	Indonesia	Sumatra	South Sumatra Province	Sg Serdang	1°44'27"S 103°52'17"E	2	1995	Bezuijen et al., 1995	
156	Indonesia	Sumatra	South Sumatra Province	Sg Serdang	2°29'00"S 104°22'00"E	2	1995	Bezuijen et al., 1995	
157	Indonesia	Sumatra	South Sumatra Province	Sg Tungkal	2°29'00"S 104°22'00"E	2	1995	Bezuijen et al., 1995	
158	Indonesia	Sumatra	South Sumatra Province	upper Sg Ogan	2°35'S 104°12'E	2	1995	Bezuijen et al., 1995	Branch of Calik River
159	Indonesia	Sumatra	South Sumatra Province	upper Sg Ogan	approx 3°01'S 104°44'E	1	1929	FMNH	Collector: Chancelor & Stuart
160	Indonesia	Sumatra	South Sumatra Province	upper Sg Ogan	approx 3°01'S 104°44'E	1	1929	FMNH	Collector: Chancelor & Stuart
161	Indonesia	Sumatra	West Sumatra Province	Sg Pangean	approx 3°01'S 104°44'E	1	1929	FMNH	Collector: Chancelor & Stuart
162	Indonesia	Sumatra	West Sumatra Province	Sg Tunjuan	0°55'S 101°20'E	3	1996	Bezuijen et al., 1997	
163	Malaysia	P. Malaysia	Pahang State	Sg Jelai	1°15'S 101°43'E	3	1994	Mr Hasan pers. comm., 1994	Photos of eggs & hatchlings shown to M.B.
164	Malaysia	P. Malaysia	Pahang State	Sg Jengka	3°09'50"N 102°36'48"E	3	Simpson et al., 1997		
165	Malaysia	P. Malaysia	Pahang State	Sg Lejar	3°31'N 102°38'E	3	Simpson et al., 1997		
166	Malaysia	P. Malaysia	Pahang State	Sg Luit	4°57'N 102°35'E	3	Simpson et al., 1997		
167	Malaysia	P. Malaysia	Pahang State	Sg Pahang	4°45'N 103°16'E	3	Simpson et al., 1997		
168	Malaysia	P. Malaysia	Pahang State	Sg Rasau	3°32'N 103°28'E	3	Simpson et al., 1997		
169	Malaysia	P. Malaysia	Pahang State	Sg Rasau	2°57'N 102°38'E	1	Simpson et al., 1997		Lower jaw photographed
170	Malaysia	P. Malaysia	Pahang State	Sg Rompin	2°57'N 102°38'E	3	Simpson et al., 1997		
171	Malaysia	P. Malaysia	Pahang State	Sg Seting	2°53'N 103°20'E	3	Simpson et al., 1997		
172	Malaysia	P. Malaysia	Pahang State	Sg Tasek	3°11'N 102°34'E	3	Simpson et al., 1997		
173	Malaysia	P. Malaysia	Pahang State	Tasek Bera NP	3°09'16"N 102°36'50"E	3	Simpson et al., 1997		
174	Malaysia	P. Malaysia	Pahang State	Tasek Bera NP	3°13'N 102°32'E	1	1940	RMBR, 1940	Collector: unknown
175	Malaysia	P. Malaysia	Perak State	Pulau Tiga, Sg Perak	3°13'N 102°32'E	1	Simpson et al., 1997		Skull photographed
176	Malaysia	P. Malaysia	Perak State	Sg Erung	4°13'N 100°50'E	1	1896	BMNH, 1896	Collector: L. Wray
177	Malaysia	P. Malaysia	Perak State	Sg Kinta	3°48'N 100°57'E	2	2003	(Stuebing, 2003)	Photos at State wildlife office
178	Malaysia	P. Malaysia	Perak State	Sg Sungkai	4°20'N 101°03'E	1	1896	Boulenger, 1896	Skull, skin
179	Malaysia	P. Malaysia	Selangor State	Parit Champeidak	3°59'N 101°07'E	2	2003	(Stuebing, 2003)+133	Photos at State wildlife office
180	Malaysia	P. Malaysia	Selangor State	Sg Tereng, Selangor	~ 3°25'N 101°30'E	1	1899	Butler, 1905	Eggs
					3°23'N 101°10'E	3	1994	Simpson et al., 1997	

Record	Country	Region	Political unit	Locality	Latitude / Longitude	Category	Date	Source	Notes
181	Malaysia	P. Malaysia	Trengganu	Tasek Kenyir	5°55'N 102°45'E	1	1999	Chan-ard et al., 1999	Juvenile
182	Malaysia	Sabah	Sandakan Residency	Sg Kinabatangan	5°29'N 118°11'E	3	2003	Zainal Abidin, pers. comm. 2003	Unconfirmed
183	Malaysia	Sabah	West Coast Residency	Sg Klias	5°26'N 115°39'E	3	2002	R. Stuebing, pers. data 2002	
184	Malaysia	Sarawak	Bintulu Division	Mukah	2°45'N 112°15'E	1	1917	De Rooij, 1917	Collector: N. De Rooij
185	Malaysia	Sarawak	Bintulu Division	Sg Penyilam	2°55'N 113°26'E	3	2004	R. Stuebing, pers. obs. 2004	
186	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2000	Bezuijen, 2004	
187	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2000	Bezuijen, 2004	
188	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2001	Bezuijen, 2004	
189	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2003	Bezuijen, 2004	
190	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2003	Bezuijen, 2004	
191	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2004	Bezuijen, 2004	
192	Malaysia	Sarawak	Bintulu Division	Sg Sarang	2°39'N 113°03'E	2	2004	Bezuijen, 2004	
193	Malaysia	Sarawak	Bintulu Division	Sg Tisak	1°20'N 111°30'E	3	1997	Cox & Gombek, 1985	
194	Malaysia	Sarawak	Miri Division	Loagan Bunut	3°55'N 114°35'E	2	2004	I. Das & K. Jensen, pers. obs	
195	Malaysia	Sarawak	Miri Division	Sg Baran	4°40'N 114°00'E	1	pre-1900	SMF	Collector: unknown
196	Malaysia	Sarawak	Semarahan Division	Sg Ensengai	1°25'N 110°40'E	2	1985	Cox & Gombek, 1985	
197	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1905	RMBR, 1905"	
198	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1893	BMNH, 1893	Collector: A. Everett
199	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1900	BMNH, 1900	Collector: C. Hose
200	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1900	BMNH, 1900	Collector: C. Hose
201	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1897	ANSP, 1897	Collector: C. Hose
202	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1897	BMNH, 1897; Boulenger, 1889	Collector: E.R. Sillwell
203	Malaysia	Sarawak	Semarahan Division	Sg Sadong	1°30'N 110°40'E	1	1917	De Rooij, 1917	Collector: N. De Rooij
204	Malaysia	Sarawak	Semarahan Division	Sg Sarawak	1°38'N 110°27'E	1		NMNH	Collector: W.T. Hornaday
205	Malaysia	Sarawak	Sri Aman Division	Sg Dor	1°15'N 111°25'E	3	1985	Cox & Gombek, 1985	
206	Malaysia	Sarawak	Sri Aman Division	Sg Kelath	1°20'N 111°20'E	3	1985	Cox & Gombek, 1985	
207	Malaysia	Sarawak	Sri Aman Division	Sg Kerang	1°15'N 110°45'E	3	1985	Cox & Gombek, 1985	
208	Malaysia	Sarawak	Sri Aman Division	Sg Lupar	1°30'N 111°00'E	3	1993	Sebastian, 1993a, b	
209	Malaysia	Sarawak	Sri Aman Division	Sg Maludam	1°40'N 111°05'E	3	1985	Sebastian, 1993a, b	
210	Malaysia	Sarawak	Sri Aman Division	Sg Maludam	1°40'N 111°05'E	3	1998	E. Lading, pers. comm.	