# Severe head injury in *Boiga melanota* (BOULENGER, 1896) observed in the southeastern corner of Thailand

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## INTRODUCTION

On our two week journey to South Thailand in February-March 2020, my wife Aoi and I visited the southeastern corner of the country. This area was new to me whereas my wife had made some business trips to this remote region decades before. The three southeastern provinces Pattani, Yala and Narathiwat are probably the least visited in Thailand. Tourists are discouraged from going there due to occasional terror attacks. In terms of culture and religion this area is quite different from the rest of Thailand as Muslims are the majority of the population. Usually tourists are concentrated in small parts of Thailand, but you may still encounter some throughout much of the country - although the COVID19 pandemic has dramatically stopped tourism in Thailand, same as elsewhere in the world. The pandemic began a couple of weeks after our journey, but we did not see one single westerner in these three provinces and had a pleasant stay! The fourth province in Thailand dominated by Muslims is Satun in the very southwest where terror attacks generally do not occur.

Figure 1. Planning the night trip. The farmer who lives and works in the area (left) we are going to visit, explains where we should go.

This report deals with my observations made on a night trip in the southern part of Narathiwat Province, 2-3 km from the border of Malaysia and 55 km from the Gulf of Thailand, on 25 February 2020. The locality was north of Hala Bala, Chanae district, coordinates 5.82477° N, 101.84714° E, 50 m elevation. It was in cultivated land – a rubber plantation and some open field – but with an important riparian habitat of trees, shrubs and open areas dominated by grass vegetation. Most observations were made in the latter habitat. The primary stream was the Ba La River, a tributary to the larger Ko Lok River comprising the border to Malaysia. There were also smaller streams and ponds and there was no forest in the vicinity.

Usually my wife and I prioritise habitats of rainforest and other primary forest when we travel in Thailand, but it proved impossible to stay overnight in the Hala Bala Wildlife Sanctuary, which is approx. 5 km to the south, as we had not made reservations in advance. Instead I got the opportunity to make a night outing in farm land and adjacent natural habitats. It was arranged by the local naturalist and guide, Sulfadlee Hagisanawee, in conjunction with the inhabitants living and working there (fig. 1). He and his friend accompanied me on the trip.

In this article an unusual encounter at night with a large *Boiga melanota,* which had been exposed to a severe injury to the head, is described and discussed. On the same night and in the same habitats the following two amphibians (normally found in primary forest) and four reptiles were recorded as well:

*Leptobrachium hendricksoni* Taylor, 1962 – Spotted Litter Frog
*Microhyla berdmorei* (Blyth, 1856) – Pegu Narrow-mouthed Frog
*Siebenrockiella crassicollis* (Gray, 1831) – Black March Turtle
*Eutropis multifasciata* (Kuhl, 1820) – Many-lined Sun Skink
*Dendrelaphis pictus* (Gmelin, 1789) – Southern Painted Bronzeback
*Homalopsis buccata* (Linnaeus, 1758) – Malayan Masked Water Snake or Puff-faced Water Snake

## *BOIGA MELANOTA* (BOULENGER, 1896) – WESTERN MANGROVE CAT SNAKE

Until recently the Mangrove Cat Snakes, or just Mangrove Snakes, of Thailand were considered to belong to the species *Boiga dendrophila* (Boie, 1827), subspecies *melanota*. But in a phylogenetic study based on sequencing of mitochondrial and nuclear DNA**,** *melanota* was elevated to species level (WEINELL et al., 2020). The taxon *Boiga tanahjampeana* proved to be the sister taxon of *melanota,* which caused *dendrophila* s.l. to be paraphyletic. Since the authors preferred to maintain the species level status of the morphologically distinct *tanahjampeana*, elevating *B. dendrophila melanota* to the taxonomic status of a species was required.

Members of the *B. dendrophila* complex are not likely to be confused with any other species in their habitat: the body colour is deep black with yellow vertical bars, although cases of melanism or the yellow pattern replaced by a whitish coloration occur (VOGEL, 2000). The head is black above with bright-yellow, black-edged labials. The chin and the anterior part of the throat are yellow. They are large colubrids attaining a total length up to 250 cm, allegedly even 280 cm, and the body is vertically compressed. They are rear-fanged and venomous with enlarged grooved maxillary teeth and the palatine teeth are also enlarged (SMITH, 1943). Though several colubrids like the genera *Dispholidus*, *Philodryas*, *Rhabdophis*, *Tachymenis* and *Thelotornis* contain species responsible for serious (including fatal) human envenomations, *B. dendrophila* s.l. and other members of the genus *Boiga* are generally not considered dangerous to humans and other large mammals (MINTON, 1990; DAVID & INEICH, 1999; SAVIOLA et al., 2014; WEINSTEIN, 2017). Earlier studies of Duvernoy's secretions of *B. melanota* determined by injection in mice demonstrated low lethal potency (WEINSTEIN & SMITH, 1993; MACKESSY, 2002). Their toxins are, nevertheless, tremendously powerful to other vertebrates.

*B. melanota* is a common arboreal species in South Thailand where it occurs in a variety of evergreen and mixed dipterocarp forests, including secondary forests (CHAN-ARD et al., 2015). It is usually found in well-watered areas such as edges of streams, rivers and mangrove swamps (GRISMER, 2011). It is also a good swimmer. In spite of their nocturnal habits members of the *B. dendrophila* complex are commonly encountered during the day coiled in branches though it may also retreat into tree holes (DAVID & VOGEL, 1996; GRISMER, 2011). Being large and conspicuously coloured they may be easily detected and potentially killed by humans.
The diet of *B. dendrophila* s.l. is well documented and consists of a wide variety of birds and lizards, but regularly mammals, snakes and frogs are eaten, and to a small extent even crabs, slugs and possibly fish (GREENE, 1989, VOGEL, 2000, BRINGSØE, in press).

## OBSERVATIONS

At 20:25 h on 25 February 2020 (one hour after sunset), north of Hala Bala, Chanae district, Narathiwat province, Thailand (5.82477° N, 101.84714° E; WGS 84; 50 m elev.), the author observed an adult *B. melanota* (184 cm total length, see fig.2) swimming in shallow water near the bank of the Ba La River, a tributary to the larger Ko Lok River which forms the border to Malaysia . The habitat was uncultivated land with scattered trees and shrub vegetation along the stream, and bordered rubber plantations (fig. 3). This individual showed a severe injury on the left and posterior part of the head's dorsal side (figs. 4-5). The wound was deep and had especially affected the left labial region, and a considerable portion of the underlying bone had been destroyed and was missing. Hence the mouth could not close properly on the left side. The wound also reached the dorsal side of the head just behind the left eye. Here it was bifurcated: the larger cut went from behind the eye obliquely toward the median

Figure 2. The author with the adult *Boiga melanota*, total length 184 cm, found in shallow water of the major stream.

Photo: Sulfadlee Hagisanawee

line of the head, whereas a minor cut started from behind the eye obliquely towards the neck. A superficial scar appeared in the left side of the anterior part of dorsum (figs. 5-6).

There was no indication of infection and though the wounds were not fully healed, they seemed to be in the process of healing. The underside of the head and of the anterior part of the body proved undamaged and without any sign of injury or wound. Possibly the left venom gland had been destroyed. The snake appeared well-nourished, strong, aggressive and healthy, so the critical phase might have been passed successfully.

## DISCUSSION

Considering the lack of injury on the ventrum of the head i.e. on the chin and lower labials, and other parts of the body, I find it unlikely that the severe attack that destroyed bones had been caused by any non-human animal. A bite inflicted by e.g. a civet or domestic cat with strong bite-force and sharp teeth might destroy part of the snake's skull, but would probably have caused additional damage elsewhere on the head, e.g. on the underside, because it will need to get a firm gripping bite with the upper and lower jaw. On the contrary an attack by a human such as an agricultural worker using an agricultural tool would fit with the appearance

Figure 3. The habitat where *Boiga melanota* was found at night. It was observed in the water near the bank in front of the person. Photo taken on 6 July 2020 by Sulfadlee Hagisanawee

of the wounds. Hoes and sickles are commonly used in Southeast Thailand and such a tool might well have been used for the attack. Malicious and wanton killing of snakes, including harmless species, by humans is known over much of the world (DODD, 1987). Nevertheless, this *B. melanota* might well have survived the injury considering the condition of the snake appearing strong and well-nourished and the healing state of the wounds.

It is likely that the trauma more than bisected the left-most of the snake's two Duvernoy's venom glands and probably even destroyed it (figs. 4-5). A minor part of the anterior lobular section may still be there. Furthermore, there is apparently a remnant of the quadratomaxillary ligament and possibly one of the associated mandibular muscles slightly visible (Weinstein, pers. comm.). These could also be damaged. See the schematics and explanations in RIEPPEL (1980) and MCDOWELL (1986). It seems likely that the left-most of the snake's two venom glands had been destroyed by the injury. The important role of the venom in prey-handling of *B. dendrophila* s.l. has been treated in a number of studies. The Duvernoy's secretion of *B. melanota* exhibits significant haemolytic activities (BROADERS & RYAN, 1997). Boigatoxin-A, a three-finger toxin (3FTX) and non-enzymatic protein has been isolated from the venom of *B. d. dendrophila* (LUMSDEN et al., 2005; HEGDE et al., 2010). It causes weak postsynaptic neurotoxicity in skeletal muscle and furthermore it exhibits prejunctional neurotoxic activity in smooth muscle of the rat vas deferens. Denmotoxin, another three-finger toxin being 77 amino acid residues long and with five disulfide bonds, has also been isolated from the venom of *B. dendrophila* s.l. (HEGDE et al., 2010; SAVIOLA et al., 2014). It produces potent and irreversible neuromuscular blockade of chick biventer cervicis muscle preparations. It shows a 100-fold weaker and reversible inhibition of electrically induced twitches in mouse hemidiaphragm nerve-muscle preparations and is considered a bird-specific toxin. Moreover, irditoxin, a dimeric neurotoxin composed of two three-finger toxins, has been recorded in *B. d. dendrophila* and several other *Boiga* species; it is crucial as it is highly toxic to diapsid (birds and reptiles) prey, but has nearly no effect on synapsids (mammals), i.e. roughly 1000 × less potent to them (DASHEVSKY et al., 2018). It is rather unusual that three-finger toxins are taxon-specific, which illustrates the link between venom toxin evolution and prey preference (PAWLAK et al., 2006, 2009).

Other components of *Boiga dendrophila* s.l. venom and their characteristics have been reviewed by SAVIOLA et al. (2014).

Figure 4. Adult *Boiga melanota* with a severe and deep injury on the left side of the head.

Figure 5. The head injury of *Boiga melanota* was apparently without infection and in the process of healing. Notice there was also a mild injury on the left side of the front of the body.

Which impact could it have for the large *B. melanota* when one of the two venom glands has probably been destroyed? Would the snake still be able to hunt and kill birds although its venom yield might have been halved? In another bird-eating member of the genus possessing three-finger toxins targeting natural avian prey, *B. irregularis*, the venom yields of large individuals commonly exceeds 20 mg

Figure 6. The adult *Boiga melanota*, total length 184 cm, found in shallow water of the major stream.

which can kill 9 kg-equivalents of bird (domestic chicken) corresponding to approx. three adult chickens (PAWLAK et al., 2009; MACKESSY, 2010). In *B. irregularis*, irditoxin is also essential for its predation on birds. On that basis the available venom yield of the injured adult *B. melanota* would easily be able to kill avian prey whose body weight is assumed not to exceed 300 g. Namely the more common birds seen in *Boiga* habitats are the size of thrushes, pittas and similarly small species.

In an analysis of the hydrodynamics of venom in interaction with the groove geometry it has been suggested that the enlarged rear maxillary teeth as seen in e.g., *Boiga* spp. can deliver venom effectively and fairly rapidly into wounds (YOUNG et al., 2011).

Little has been published about snakes surviving severe injury. GREENE (1988) provided a superficial review of injury in wild reptiles, but some cases were subsequently treated in captivity.

HEYBORNE et al. (2020) observed an adult *Pituophis catenifer deserticola* with an open perforation in the neck. The length of the wound was approx. 40 mm. The authors considered attempted predation as a plausible explanation. However, I believe the injury might also have occurred during swallowing of a large prey which could potentially still have been alive and struggling fiercely thus creating the large wound.

KOLODZIEJ & CENKER (2019) described an adult *Zamenis longissimus* found in the wild in Austria lacking both eyes. It was strong and well-nourished. There was no sign of injury around the orbits. Potentially this was a case of anophthalmia (congenital).

A number of studies of injury in snake populations have been made, however, severe injuries are generally not reported. An intriguing exception is island populations of *Notechis scutatus* in which gulls and other birds peck at the heads of the snakes (AUBRET & THOMAS, 2009). In one population 7.5% were blind and 6.6% half blinded and large scars were observed. In a Hungarian population of *Dolichophis caspius* 22% of the captured individuals had scars, but none on the head (FRANK & DUDÁS, 2019). It was suggested that body scarring did not decrease foraging success and associated growth. NAGY (2001) made a survey on *Natrix natrix* with injuries in a habitat dominated by fish ponds in Hungary. 54% of 186 individuals had various types of injury, predominantly on the tail, to a lesser extent on the body and fewest injuries were on the head. There were even four cases in which fish bones had penetrated the body or throat from the inside. In a study in Poland 104 live *Natrix natrix* were recorded, 18 of which had scars and injuries (BORCZYK, 2004). 5 of the 18 injuries were on the head. Furthermore 18 dead individuals were collected, 14 of which were road-killed. In KABISCH' (2020) detailed review of predation on *N. natrix* additional examples of surviving individuals with scars after injuries are also provided. Most cases were believed to have been caused by mammalian attacks. GREGORY & ISAAC (2005) recorded injuries in an English population of *N. helvetica* suffering from broken bones, assorted scars and wounds and tail loss. In an Austrian population of *N. tessellata* 15% had fresh or healed injuries, mostly missing tail tips (SMOLE-WIENER, 2011).

A particularly serious type of human-caused injury in snakes is road-kills: confrontation with vehicles have very high mortality rates (SANTOS et al., 2011, WINTON et al., 2018).

## SUMMARY


A record of a large *Boiga melanota* with a severe head injury is provided. It was found in a stream on a night trip in a cultivated area in Southeast Thailand in the southern part of the Narathiwat Province. The injury was in the left part of the head, just behind the left eye. A considerable portion of bone had been destroyed, the mouth could not close properly in the left side, and the left venom glands might well have been destroyed. The quadratomaxillary ligament and a mandibular muscle were probably also traumatized. There was no sign of infection, and the snake was fresh, aggressive and well-nourished. It is likely that the injury was the result of a human attack using an agricultural tool such as a hoe or sickle. It is judged that it might well have recovered fully and survived.

The venom of *B. dendrophila* s.l. contains three-finger toxins such as irditoxin, which are highly toxic to birds and reptiles but have little effect on mammals. It is concluded that even with only one venom gland the injured *B. melanota* has probably been able to easily kill birds and reptiles with its venom.

Severe injury in wild snakes having survived is seldom reported. A review of other published cases of injured wild snakes which have survived is made. Cases of wild snakes surviving severe injury are rarely reported. The published cases that exist are reviewed here. The injuries discussed appear to be considerably milder than the one described for *Boiga melanota.*


## SAMENVATTING


De vondst van een grote *Boiga melanota* met een ernstige verwonding aan de kop wordt beschreven. Het dier werd aangetroffen in een rivierarm tijdens een nachtelijke tocht in bouwland in het zuidoosten van Thailand, in de provincie Narathiwat. De verwonding was links op de kop, achter het linkeroog. Een flink stuk bot was beschadigd, de bek kon links niet goed meer sluiten en de linker gifklieren waren mogelijk aangetast. Het quadratomaxillaire ligament en een kaakspier waren wellicht ook verwond. Er toonden zich geen tekenen van infectie en de slang oogde levendig, agressief en goed doorvoed. Waarschijnlijk was de verwonding het resultaat van een aanval door de mens met een schoffel of kapmes. Aangenomen mag worden dat de slang de aanval verder overleefde.

Het gif van *B. dendrophila* s.l. bevat drievingerige toxines zoals irditoxine, die in hoge mate giftig zijn voor vogels en reptielen, maar weinig effect hebben op zoogdieren. Zelfs met maar één gifklier kan de gewonde *B. melanota* in staat geacht worden om met gemak vogels en reptielen te doden met zijn gif. Zelden is beschreven dat ernstig gewonde slangen in het wild zijn hersteld. De enkele publicaties waarin dat gerapporteerd wordt, haal ik hier aan. Waarbij gemeld zij dat die verwondingen aanzienlijk geringer waren dan in het onderhavige geval.


## ACKNOWLEDGEMENTS


I thank Sulfadlee Hagisanawee (Ban Hala Bala, Narathiwat, Thailand) for arranging the night trip and taking habitat photos subsequently. L. Lee Grismer (La Sierra University, Riverside, California, USA), Parinya Pawangkhanant (University of Phayao, Phayao, Bangkok, Thailand), Jeffrey L. Weinell (University of Kansas and Biodiversity Institute, Lawrence, Kansas, USA), and Scott A. Weinstein (Women's and Children's Hospital, Adelaide, SA, Australia) contributed useful information.

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