

First data on Odonata of Prey Long Forest in Cambodian Lowland

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Abstract

Prey Long (Prey Lang) Forest is the largest remaining lowland rainforest in Indochina, shared by Stung Treng, Preah Vihear, Kampong Thom and Kratie Provinces of Cambodia, which has been persisted until present because of the lack of roads. It includes patches of unique evergreen swamp forests. Odonata of Prey Long forest, including Cheum Takong forest swamp, was briefly examined in December 2019, while the already deforested area was examined in June 2018. The former examination resulted in 40 species, the latter in 34 species, 60 species in total. Two species, *Copera chantaburii* Asahina, 1984 and *Burmagomphus williamsoni* Förster, 1914, are for the first time reported for Cambodia from the deforested area (Chey Saen District of Preah Vihear Province). The swamped forest of Cheum Takong provided 17 species, 5 of which were not found elsewhere in the considered area, 3 are rare and 4 generally Sondaic. Prey Long Forest should be re-examined in the rainy season soon after the road to Spong village is constructed.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Cambodian Lowland, lowland rainforest, swamped forest

Introduction

Cambodian Lowland is a great extension of the lowermost valley of the Mekong River and is filled with its sediments. Once covered by lowland tropical forest, long ago it was mostly cleared and converted into arable land. In XI-XIII centuries this was one of the most populated areas in the world, supporting the famous Angkorian Civilisation which existed since IX century. Most of the lowland is almost infinite rice field with scarce trees grown for purpose, e.g. picturesque Palmyra Sugar Palm (*Borassus flabellifer* L.). Nevertheless, large areas of pristine rainforest have been persisting there until present. The largest of them, among the largest lowland tropical forest in the Old World, Prey Long Forest (or Prey Lang; 'our forest' in the language of the local Kuy minority (Turreira-Garcia et al., 2017)) is situated between Lake Tonle Sap and the Mekong River and shared by Preah Vihear (west), Stung Treng (east), Kratie (south-east) and Kampong Thom (south) Provinces (Fig. 1). It is being furiously logged in the latter, in spite of its status of a wildlife sanctuary. Since lowland wood is cheap to log and transport, persistence of Prey Long Forest was a matter of absence of roads, so



Figure 1. A Google Earth view on Prey Long Forest, with localities studied (Loc.1 – 9; see the text) indicated.

that as soon as a road appears the forest is gone. Before the absence of roads, Prey Long remained totally unexplored scientifically until very recently. Actually it was discovered for science by J. Andrew McDonald (2004) who issued a report 'Ecological Survey of Prey Long, Kampong Thom; a Proposal for the Conservation of Indochina's Last Undisturbed Lowland Rainforests' based on the results of his expedition to Prey Long in 2004. In particular, he discovered and for the first time described the previously unknown peculiar evergreen swamp forest type of the Cambodian Lowland, examined by him at the Cheum Takong forest swamp.

Swamp forest is among the most promising habitats for faunistic studies of Odonata, as scarcely left in the world, hard to access and possessing elusive species strictly confined to this habitat type. It was natural to undertake the first examination of Odonata of this unique area. I made three attempts. The first goal was to get to the village of Spong, the deepest immersed into Prey Long in its northern part at the junction point of three provinces but attributed to Stung Treng Province. First, in July 2016, I tried to get there via motorbike from Stung Treng City in north-east via Road 216 (the road which was used by McDonald's team in 2004) but at the village of Rumdeng concluded this was hardly possible because of a bad state of the road. Next, with local guides from Siem Reap, Poly Pey and Sok Ngov, I tried to approach the forest by car in June 2018. At first, on 19.06.2018, we took the same road from Stung Treng but reached only Veal Pou village to learn there was no accessible road further. Next day we made a big circle and tried to approach Spong from Chey Saen District of Preah Vihear Province in the west. The first attempt was made from Putrea village by the opposite side of the same Road 216, which also appeared impassable, and then via Road 215 from Phneak Roleuk village. At this village we were told that a Chinese tractor would come from Spong and return the same evening, but instead its driver came on foot at twilight to tell that the tractor had been stuck in mud. As a

result, on 21.06.2018 I had to examine the recently logged area around Phneak Roleuk and at some sites to the west along Road 215 to Chey Saen village. We were advised to get to Spong in a dry season, not so suitable for an Odonata faunal study. We nevertheless followed this advice and in December 2019 managed to get (Fig. 2) to Spong, from where local guides brought me by a motorbike to Cheum Takong ever-green forest swamp, which was my main target and where I spent two days.



Figure 2. On the way to Spong village through Prey Long Forest on Chinese tractors, 4.12.2019.

The results of Odonata observation during these trips is delivered below, although a deforested plantation area with many considerable rivers in the rainy season is hardly comparable with a huge virgin rainforest almost devoid of rivers amidst the dry season.

Methods

Common species were recorded by sight while walking (Fig. 11 bottom left), some specimens were collected and stored in the author's collection and Naturalis Biodiversity Center, Leiden, the Netherlands. Photographs of landscapes and Odonata (in purely natural conditions, never posed) were taken with Canon EOS 350D cameras with a Sigma AF 24-70 mm F2.8 EX DG MACRO lens. The photos of Odonata have been submitted to iNaturalist.org (see the user @oleg_kosterin and the project 'Odonata of Cambodia') Coordinates, in the decimal degree format, were recorded by Garmin eTrex H personal GPS navigator but their ranges for the areas actually examined were revised using Google Earth. The dates are provided in the dd.mm.year format. The disposition of localities examined (Loc.1 – Loc.9) is shown in Fig. 1. For authorities and dates of the Odonata species mentioned see Table 2.

The area

Prey Long Forest extends for ca 73 km both from north to south (ca 12.9-13.6 N) and from west to east (ca 105.3-106.0 E) at elevations 70-170 m a.s.l., occupying 530,000 ha (Turreira-Garcia et al., 2017). According to McDonald (2004), the most widespread plant community of Prey Long is (i) primary tall semi-evergreen dipterocarp forest (dominated by *Dipterocarpus*, *irvingia* and *Syzygium* spp.); other vegetation types occupying less areas are (ii) short semi-evergreen dipterocarp forest, (iii) short deciduous forest (dominated mostly by *Dipterocarpus intricatus* Dyer), (iv) tall sralao (*Lagerstroemia* spp.) forests, (v) short riparian and *Melaleuca* forest, (vi) deciduous swamp forest (at Lake Boeng Pes) and (vii) evergreen swamp forest (at Cheum Takong forest swamp). The water bodies are surprisingly scarce in Prey Long Forest, although it is drained with several small rivers, such as Siembok, Porong, O'Long, Chinit, O'Kachong and O'Ronoul and their smaller tributaries (McDonald 2004). There are also a small Lake Boeng Pes and some forest swamps locally called 'Cheum'. I examined two of them, to find them strongly differing from each other (see below).

I examined four sites in the Prey Long northern part (13-32-13.45 N, 105.61 E) as based at Spong village (ca 13.45 N, 105.50-105.54 E) on 5-8.12.2019. On 20-21.06.2018, I also briefly examined an already cleared area, supplanted by plantations, to the west of this part of the forest in Chey Saen District of Preah Vihear Province along Road 215, from Chey Saen village to slightly SE of Phneak Roleuk village (ca 13.62-13.50 N, 105.36-105.48 E). This area is crossed by several considerable rivers.

Results

1. Deforested area in Chey Saen District (Preah Vihear Province), 21th June 2018

Loc. 1. 3.6 km SE of Chey Saen village, a small (2-3 m wide), shallow, moderately fast river with slightly turbid water, shaded by strips of trees and spiny bamboo, flowing across short open deciduous dipterocarp forest with some rice fields. 13.6243-6247 N, 105.2844-2851 E, 63 m a.s.l.

Loc. 2. Chrach Commune, a medium-sized river in Pramoll Phdom village, with deep reaches and sandy shallows. 13.611-612 N, 105.363-364 E, 80 m a.s.l.

Loc. 3. Thmea Commune, a medium-sized river in Thmea village, with turbid water, sandy banks, solitary trees and bunches of spiny bamboo at banks. 13.602-603 N, 105.433-435 E, 95 m a.s.l.

Loc. 4. Thmea Commune, Phneak Roleuk village southern margin, a long turbid pool between a road and tall semi-evergreen dipterocarp forest remnants. A deeper small swamp with *Persicaria* sp. nearby. Smaller pools on the road further south. Forest remnants, clearings, young banana plantations and small rice fields around. 13.5235 N, 105.4754 E, 130 m a.s.l.

Loc. 5. Thmea Commune, 3 km SE of Phneak Roleuk village, a medium-sized river at the bridge (Fig. 4). Mostly shaded by trees, the water moderately turbid. An open area nearby bordered with trees at the river and shrubs. 13.506 N, 105.482 E, 130 m a.s.l. **Loc. 5a.** 2 km SE of Phneak Roleuk village, a tiny brook crossing a road through forest remnants, 13.5136 N, 105.4773 E, 134 m a.s.l.

Loc. 1-3 were briefly examined on 21.06.2018, Loc. 4-5 in the evening of 20.06.2018 and in the morning of 21.06.2018. The primary data from Loc. 1-5, including observa-

tions, collections and photographs, are provided in Table 1. It contains 34 recorded species, four of which are remarkable.

Table 1. Details of observations and collections of Odonata species made in the deforested Chey Saen District of Preah Vihear Province on 20-21.06.2018. 'Coll.' means 'collected', 'photo' – 'photographed in nature'. For explanations of localities see the text, for species authorities and dates see Table 2.

Species	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5
<i>Vestalis gracilis</i>	-	-	-	-	many seen
<i>Libellago lineata</i>	-	several seen	several seen	-	several ♂♂, ♀♀ seen, 1 ♂ photo
<i>Lestes elatus</i>	-	-	-	3 ♂♂ (1 teneral) 1 ♀ coll., 2 ♂♂ (1 teneral) photo (Fig. 4)	-
<i>Agiocnemis pygmaea</i>	-	-	-	2 ♂♂ coll.	-
<i>Ceriagrion calamineum</i>	-	-	-	2 ♂♂ coll.	-
<i>Ceriagrion indochinense</i>	-	-	-	many subfeneral seen, 3 ♂♂, 1 ♀ coll.	-
<i>Pseudagrion australasiae</i>	-	-	-	1 ♂ coll.	-
<i>Pseudagrion williamsoni</i>	-	1 ♂ seen, 1 ♀ coll.	-	-	-
<i>Copera chantaburii</i>	-	-	-	1 ♂, 1 ♀ coll, 1 more m seen	-
<i>Copera marginipes</i>	1 ♂, 1 teneral seen	-	-	-	1 ♂ coll. in thickets at bank
<i>Prodasineura autumnalis</i>	several seen	several seen	-	-	several ♂♂ seen, 1 coll.
<i>Burmagomphus sp. cf. williamsoni</i>	-	1 teneral ♂ coll.	-	-	-
<i>Ictinogomphus decoratus melaenops</i>	-	-	-	2 ♂♂ seen	1 ♂ seen at a glade
<i>Macrogomphus albardae</i>	-	-	-	1 ♂ coll. at Loc. 4a	-
<i>Macromia sp.</i>	-	-	-	-	1 ♀ coll. (Fig. 5)
<i>Brachydiplax farinosa</i>	-	-	-	1 teneral ♂ coll., several mature ♂♂ seen at a deeper pool, 2 ♀♀ photo (Fig. 6a-b) and coll. at a road apart	-
<i>Brachythemis contaminata</i>	-	-	-	many seen	-

Species	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5
<i>Cratilla lineata calverti</i>	-	-	-	1 ♂ coll. at a big roadside pool, 1 more photo (Fig. 7)	several seen, at a road nearby
<i>Crocothemis servilia</i>	-	-	-	several seen	-
<i>Diplacodes nebulosa</i>	-	-	-	1 ♀ seen	-
<i>Diplacodes trivialis</i>	-	several seen	several seen	several feneral seen	-
<i>Lathrecista asiatica</i>	-	-	several seen	1 feneral ♀ photo (Fig. 8a)	1 ♂ seen
<i>Neurothemis fulvia</i>	-	-	-	many feneral seen, 1 mature ♂ seen at a road	several seen at a glade
<i>Neurothemis intermedia atalanta</i>	several seen	several seen	-	many subfeneral seen	-
<i>Onychothemis testacea</i>	-	several ♂♂ seen	many ♂♂, several ♀♀ seen	-	several ♂♂ seen, 1 coll., 1 photo (Fig. 9). 1 ovipositing ♀ seen
<i>Orthetrum chrysis</i>	-	-	-	2 ♂♂ seen at roadside pools	-
<i>Orthetrum neglectum</i>	-	-	-	1 ♂ seen at a road pool	-
<i>Orthetrum sabina</i>	-	-	-	several seen	1 ♂ seen
<i>Pantala flavescens</i>	-	-	-	small swarms over glades	-
<i>Potamarcha congener</i>	-	-	-	many feneral seen, 1 feneral ♂ photo (Fig. 10), 1 feneral ♀, 1 ovipositing ♀ collected	1 ♂ photo
<i>Pseudothemis jarina</i>	1 ♂ seen	-	-	-	-
<i>Tholymis tillarga</i>	several ♀♀ seen	-	-	many seen (evening 20.06.2018)	-
<i>Trithemis aurora</i>	-	-	-	7 ♂♂ seen	-

Copera chantaburii is new addition of the country list. The former was collected at a large roadside pool by forest remnants at Phneak Roleuk village. The female of *Burmagomphus* sp. cf. *williamsoni* was collected at maiden flight at a considerable river at midday and let to get colours and harden in captivity. A male of *Macrogomphus albardae* flew swiftly to and fro lower over a road with a tiny brook (Loc. 5a) in dusk of 20.06.2018. This taxonomic treatment follows (Kosterin 2019) where this observation is mentioned and the specimen illustrated (Kosterin 2019: fig. 5). The female of *Macromia* sp. (Fig. 5) flew fast over the half-shaded surface of a medium-sized river at ca. 9:20 a.m.

The big roadside pool at the Phneak Roleuk lower margin, by a tall semi-evergreen forest remnants, appeared very reach for such a seemingly poor habitat, with 24 species revealed for two short observations in the evening and morning (Table 1)!



At Loc. 2 and 5, I observed females of *Onychothemis testacea* ovipositing around lianas immersed into river. At Loc. 2 it was a thin liana stem with roots and some rubbish. The female was captured and immediately another one appeared and started to oviposit at the same place. When it was captured as well, very soon a third individual appeared and flew around the same stem but it turned to be a male! Obviously, that preferred ovipositing site was a matter of competition among females and attention by males. At Loc. 5, a female oviposited at a thick liana stem spun with rubbish.

Figure 3. A medium-sized river 3 km SE of Phneak Roleuk village, 21.06.2018 (Loc. 5).



Figure 4. A male of *Lestes elatus* at a long roadside pool at S margin of Phneak Roleuk village, 21.06.2018 (Loc. 4).

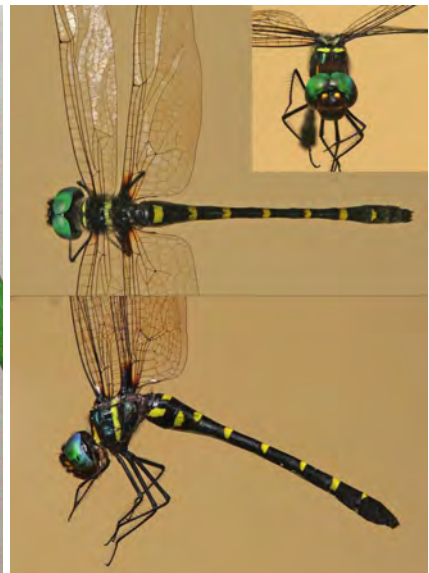


Figure 5. A female of *Macromia* sp. from the river 3 km SE of Phneak Roleuk village, 21.06.2018 (Loc. 5; Fig. 2).

Figure 6. Females (a-b) and a male (c) of *Brachydiplax farinosa*: a-b - at S margin of Phneak Roleuk village, 21.06.2018 (Loc. 4); c – at a pool in Cheum Takong (Loc. 5), 5.12.2019.

2. Prey Long forest in December 2019

Since the water bodies examined in this area had little in common with each other with respect to both environment and dragonfly and damselfly species composition, it would not be useful to provide a united list or table, so these localities and their odonate assemblages will be described separately (with the total faunal data from all over the area considered in this paper summarised in Table 2).

2.1 Cheum Thom swamp (Loc. 6)

Cheum Thom is an open boggy area 5.2 km W of Spong village, still in Preah Vihear Province, 13.456 N, 105.498 E, 117 m a.s.l. It was examined from 10:40 a.m. to 1:10 p.m. on 8.12.2019. The main area is evenly filled with fine Poaceae grass soaking with water, from ankle to waist height, sometimes forming a shaky floating bog. The most numerous dragonfly of the grassy bog was *Nannophya pygmaea* (mostly males but also females and teneral; 1 ♂ 1 ♀ collected).

Other dragonflies were very scarce; a male of *Diplacodes nebulosa* and a mature, red male of *Neurothemis intermedia atalanta* (collected) were met. Males of *Ceragrion cerinorubellum* were frequent. Surprisingly, net sweeping over the grass did not provide *Agrionemis* or any other damselfly. The bog is fed by a brook flowing from the forest and entering its end opposite to the road. At this point the grass becomes taller and pools of open water appear. Dragonflies became more frequent there: few males and a female of *Neurothemis fluctuans*, a female of *N. intermedia atalanta* (collected), a male of *Orthetrum sabina* and a male of *Orthetrum luzonicum* were found. *C. cerinorubellum* appeared more numerous there (2 ♂♂, 1 ♀ collected). For some distance, the brook flows along the forest margin





Figure 7. A male of *Cratilla lineata calverti* at forest remnants at S margin of Phneak Roleuk village, 21.06.2018 (Loc. 4).

through a series of pools. Here four males of each *Archibasis viola* and *Pseudocoptera ciliata* were found (1 of *P. ciliata* collected). At several shallow pools with surprisingly firm bottom *Agriocnemis* was at last found, 2 males and 2 females of *A. minima* (collected) and 1 male of *A. nana*. A small rivulet flows from the bog, crosses the road and proceeds in a shady valley. At its temporarily dried out arm, with wet bottom, I encountered the only individual of *Vestalis gracilis* (although expected more) and a female of *Heliocypha biforata* (collected).

2.2 Lake Boeng Pes (Loc. 7)

Lake Boeng Pes (13.447-448 N, 105.505-506 E, 128 m a.s.l.) is situated 4.5 km WSW of Spong village but still in Preah Vihear Province. It is quite peculiar and unexpected amidst the vast and even Prey Long Forest. Superficially it looks like an oval grassy glade but is actually a lake more than man height deep, but almost entirely filled with emergent spikerush (*Eleocharis* sp.) (Fig. 11). Between its stems there was



Figure 8. Females of *Lathrecista asiatica*: a – a general one at a long pool at S margin of Phneak Roleuk village, 21.06.2018 (Loc. 4); b – at the Spong River in Spong village (Loc. 8), 8.12.-2019.

also some abundant hydrophyte with whorls of filiform pinnate leaves. Only at the bank with the road there were small areas of open water (from knee to chest deep). The water was full of small fish. The banks were margined with walls of lush vegetation with participation of *Ligodium* winding fern. There were small bays, most probably with small brooks entering.

McDonald (2004: 20-21) characterised the forest around Boeng Pes as follows: "The deciduous forest that surround Pes Lake (Boeng Pes) comprises a very unique vegetation type in the region, as it combines the attributes of a marsh forest, dry-deciduous forest, and riparian forest ... This aquatic ecosystem is surrounded by sandy soils which quickly turn dry about 50 m from the lakeside. One is given to assume that the sand-rimmed lake sits upon a deep foundation of clay. This being the case, a dry-deciduous forest comes into direct contact with an aquatic substrate



Figure 9. A male of *Onychothemis testacea* at the river 3 km SE of Phneak Roleuk village, 21.06.2018 (Loc. 5; Fig. 2).



Figure 10. A feneral male of *Potamarcha congener* at a long pool at S margin of Phneak Roleuk village, 21.06.2018 (Loc. 4).

and ecosystem, the interface of which sequesters a number of highly specialized aquatic trees and shrubs. Upper-story trees of Boeng Pes include stieng (*Archyteaea* sp.; a rare species with close relatives in New Caledonia), pa-ong (*Calophyllum saigonense* Pierre), pdieck (*Anisoptera costata* Korth.), smach (*Melaleuca*

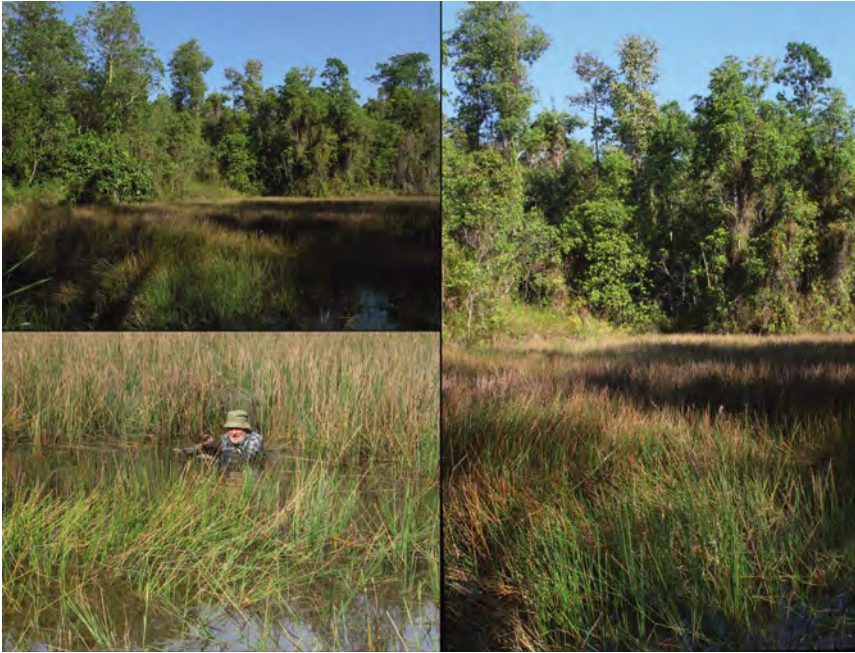


Figure 11. Lake Boeng Pes (Loc. 7).

quinquenervia (Cav.) S.T. Blake), chium (*Ilex* sp.?), popiel (*Shorea cochinchinensis* Pierre), proloab (*Ehretia laevis* Roxb.), and an unknown species by the name of srung. The most typical element of Prey Long's dry-deciduous forests, trach (*Dipterocarpus intricatus* Dyer), thrives in the water for half the year! Understory trees include stieng (*Archyteaea*), konkang (*Rhizophora* sp.), pang (*Pterospermum diversifolium* Blume), smach tuk (*Syzygium* sp.), and *Licuala* (understory palm), in association with various grasses, sedges, epiphytic ferns, rattans. Many of the upper and lower story trees are festooned with epiphytic ferns. Obviously, this plant community does not fit comfortably within standard classifications of plant cover of Cambodia, nor is it recognized on any modern maps. This speaks as much for its uniqueness as for its rarity. It is interesting that *Rhizophora* and *Melaleuca*, a lower and upper mangrove tree species (respectively), co-occur here, indicating that the lake forms a miniature mangrove (of sorts) in the middle of Kampong Thom. It is also notable that *Archyteaea*, formerly known only from boglands of the Bokor Mountain wet plateau (ca. 1200 m; Dy Phon, McDonald), occurs commonly here as both an upper- and understory tree, and often exhibits still roots ... It is also notable that choam (*Shorea*; Fig. 14) and pdieck (*Anisoptera*, a massive and dominant dipterocarp of evergreen forest) form pneumatophores (specialized aerial growth of roots) in this aquatic habitat. Yet in drier habitats the roots of these same plant species do not develop these specialized structures."

I examined Boeng Pes on 8.12.2019 at 9-10:40 a.m. and then at 1:30-2:30 p.m. The lake appeared extremely rich in dragonflies but not so in damselflies. Although in the former period of time the lake was already illuminated with bright sunshine (Fig. 11), Odonata were still much less abundant and diverse than in the afternoon; that concerned even common lotic species. This can be explained by unusually cold nights in early December 2019, with the temperature dropping down to 14-16°C, so that tropical dragonflies probably needed a considerable time to heat and reactivate.

In the morning at the water surface overgrown with spikerush, there were very numerous *N. pygmaea* (many males (1 collected), including teneral yellow ones, few females), many males and some females of *D. nebulosa* (1 ♂ 1 ♀ collected) and somewhat less numerous *Acisoma panorpoides* (1 ♂ collected); males of *Indothemis limbata* were scarce at first but many appeared soon (3 ♂♂ collected). One male of *Neurothemis tullia* was found at the water surface and one male of *O. sabina* at the road bank. Of damselflies, a male of *A. cerinorubellum* and one red immature *Agriocnemis* sp. was observed.

In the afternoon the same dragonflies remained, *I. limbata* being very numerous. Quite a few males of *O. sabina* appeared in spikerush above the surface, and I saw two copulae of this species. Few males of *Diplacodes trivialis* (1 collected) were added to *D. nebulosa*. At the spikerush-clad surface I met three males of *Rhyothemis triangularis* (2 collected), a male of *Brachydiplax chalybaea* and a male of *Aethriamanta gracilis* (with five antennodals plus one incomplete below subcosta; collected), and a young (not pruinosed) female of *Potamarcha congener* (collected). On vegetation at banks, a male of *Neurothemis fulvia*, a male of *Urothemis signata* (that perched high on a hanging thin liana, collected) and quite a few males appeared of *Orthetrum chrysis*, *Crocothemis servilia* and *Rhodothemis rufa* (1 collected) were found. I also saw two females of the two latter species: a female of *O. chrysis* was persuaded by a male through spikerush, another one sat high on *Ligodium*; of the latter species I observed an ovipositing female accompanied by a male and a very old female which was not at all cautious.

For some reason, the damselflies appeared to be much scarcer than dragonflies. A male of *Pseudocopteryx ciliata* (collected) and a male of *C. olivaceum* were found at a shallow bank by the road. In spikerush I collected a single male of *Agriocnemis pygmaea*. At some small areas of open water with sparse or none spikerush but knee-to chest deep, there was a male and tandem (collected) of *P. australasiae*, a male of *I. senegalensis* (collected, the only individual from the whole Prey Long area!) and two males (collected) of a rare species *Amphiallagma parvum*.

A brook flows from the lake, with an impenetrable valley piled with fallen trees and overgrown with spiny palms. There was a congregation of several *V. gracilis*.

2.3 Spong Rivulet (Loc. 8)

Spong is a small rivulet flowing by the village of the same name (13.46 N, 105.54 E). The rivulet serves a border between Preah Vihear Province (left bank) and Stung Treng Province (right bank, with the village). Near the village it crosses clearings of different

age, with rice field at its eastern side, and some forest remnants. Nevertheless the rivulet is mostly hidden in impermeable vegetation as being quite small. There are few places where it could be accessed, and odonatological results were poor.

One of them (Loc. 8a) was by the village (13.4556 N, 105.5421 E, 122 m a.s.l.) and hence extensively used by its inhabitants for washing, so it was not convenient to study, that I attempted in the afternoon of 7 and 8.12.2019. The left bank was clad with shady low forest with abundant low shrub with dark glossy leaves near the ground, on which extremely numerous *V. gracilis* were found. The right bank had open sandy-loam places bordered with tall vegetation. At the water, there were one male of each *Orthetrum sabina*, *O. chrysis* and *O. neglectum* (collected), the former in the grass while the two latter permanently fought for a perching place on a banana petiole lying on the bank. A female of *Lathrecista asiatica* (Fig. 8b) an immature male of *Neurothemis fluctuans*, and a female of *Heliocypha biforata* perched on the vegetation. On a shaded bank under tree canopy a male of *Copera marginipes* was collected.

The other place (Loc. 8b) was ca 700 m downstream (SW) of Spong village (13.4476 N, 105.5346 E, 123 m a.s.l.), examined on 7.12.2019. Here the river was crossed with a broad cow path, with a rice field close to its left bank and a big forest glade used for pasturing at its right bank. At the river I found only a male of *H. biforata* (collected) and a male of *V. gracilis*; at a forest margin of a glade nearby several *V. gracilis* and *N. intermedia atalanta* and a male of *Neurothemis fulvia*; on another glade a female of the latter species; and at a muddy roadside cow pool a perching male of *P. congener*.

2.4 Cheum Takong swamped forest (Loc. 9)

J. A. McDonald was the first scientist who visited Cheum Takong forest swamp and discovered there a peculiar evergreen swamped forest type, the description of which he prefaced as follows: "Over the course of our survey we were able to confirm preliminary reports of extensive, discontinuous evergreen swamp forests in the region. Based on a thorough examination of botanical literature, I can only conclude that this unique vegetation type is exceedingly rare and endemic to the region. Moreover, it is unknown to science. The first of several swampy landscapes that we encountered occurs about 25 km SSE of Spong. This swampy wetland is fed by the O'Long River, whose waters flow from the NW to SE across a tall and exuberant dipterocarp forest. I am informed that this particular swamp, known as 'Cheum Takong', measures 3 x 4 km, and that similar habitats with swamp forests occur further to the South, including the Cheum Svay, Cheum Leng, Cheum Kruich, Cheum Knong, and Cheum Tapo. All of these latter sites are said to be smaller, however, than Cheum Takong." (McDonald 2004: 22).

This vegetation type was characterised as follows (McDonald 2004: 23): "Dominant trees of this forest form a relatively irregular canopy that varies from 10-25 m tall ... most tree trunks to range from 35-100 cm. This vegetation does not exhibit the same degree of diversity as the surrounding rainforests, and is dominated (both in size and frequency of occurrence) by an unidentified tree species by the name

of 'kok'. Other subdominant tree species include chrey (a fig, *Ficus* sp.), proloab (*Ehretia laevis* Roxb.), pring (*Syzygium* sp.), konkang (*Rhizophora* sp.?), pa-ong (*Calophyllum saigonense* Pierre), pang (*Pterospermum diversifolium* Blume), and changka trang (*Orophea* sp./Annonaceae?). Even though a relatively small patch of this forest was examined, two common trees were unknown by name to our local guides! And to be sure, a visit to this region during the peak of flowering season would prove useful and likely result in the discovery of numerous new species to science. A rare but very conspicuous *Livistona* palm tree (*L. laoensis*?) is an indicator species of this vegetation type [...]. Their stems generally reach from 10-20 m tall and often present themselves as emergent in the marsh forest's closed canopies." (Fig. 15). "The understory of these marsh forests is equally unique in structure and species composition. They are dominated by dense stands of short palms to 4 m tall (*Areca* sp. [...]), smach tuk (a unique *Syzygium* sp.), krabah prey (*Macaranga*, otherwise rare in the region), pang (*Pterospermum diversifolium* Blume), bangko sva (*Aglaia* sp.), choa (*Shorea hypochra* Hance or possibly *Shorea guiso* [Blanco] Blume), krabah (*Sapium*?), and srul (*Trema*). The co-occurrence of *Trema*, *Sapium*, *Pterospermum*, *Areca*, and *Macaranga* suggest that the soil may be distinct in these wetland habitats. It is possible that laterites may be present, as the latter species tend to prosper on lateritic soils in other provinces of Cambodia. However, a very brief examination of the soil revealed only sandy clays. A variety of epiphytes were also observed on both large trees and palms."

I found out this information not too precise in the following minor respects: Cheum Takong is situated 15-16 rather than 25 km SSE of Spong and is narrow, extending for some 3 km from SSW to NNE but only some 400 m wide, obviously being a swamped river valley. The direction of the river flow is from SE to NW, that is opposite to what McDonald stated. Also Cheum Takong is situated in Stung Treng Province while McDonald (2004) attributed it to Kampong Thom Province. Since the place called Cheum Thom (Loc. 6) was so different from Cheum Takong, I doubt that other cheums mentioned by McDonald by reports of his local informants have the same vegetation as Cheum Takong.

McDonald seems not to have walked inside Cheum Takong (he wrote: "I was able to enter penetrate the rim of Cheum Takong on the back of a fallen 'kok' stump that measured over 1 m across, from which vantage point I took some snapshots of this unique vegetation type of Cambodia"; McDonald 2004: 22) hence he did not examine its interior in detail, most probably because it was not so penetrable in the rainy season. Thanks to Vann Sai, a local guide, I had an opportunity to walk inside Cheum Takong for two days, in particular we went for 2 km throughout its main axis. It is occupied by a system of many small, shallow anastomosing courses of running water, often entering shallow pools with red, muddy, sucking bottom (Figs 12-14), forming a kind of 'inner delta' of the river. They abound in upright and pointed pneumatophores of some tree (which may or may not be *Rhizophora* sp.), which made the area strongly resembling mangroves (Figs 13-14). It is noteworthy that such pneumatophores were not illustrated by McDonald (2004) (he illustrated only arched pneumatophores of *Shorea* sp. at Boeng Pes). (In the same season I saw a similar habitat with a lot of pneumatophores at a river inner delta but with more and

deeper water, called 'floating forest' by locals, on the eastern Phnom Kulen Plateau in Siem Reap Province, at Tnal Mareth terrain, 13.530 N, 104.560 E). Cheum Takong is densely overgrown with bush and arboreal vegetation and so is very dark, with few sunlit spots. A large share in vegetation belongs to palms of several species, of which the most abundant was *Licuala* sp. (not mentioned by McDonald for Choum Takong), some rattan (*Calamus* sp.) occurred, and the conspicuous, tall and elegant *Livistona* sp. which McDonald paid a special attention, was at its place (Fig. 15). The presence of the latter made improbable a supposition that locals showed McDonald and



Figure 12. Interior of Cheum Takong forest swamp (Loc. 9), 5.12.2019.



Figure 13. Pneumatophores at pools in Cheum Takong forest swamp (Loc. 9), 5.12.2019.

me different forest swamps under the same name.

The studied area of the swamped forest can be labelled as follows: Stung Treng Province, 15-16 km SE of Spong village, Cheum Takong swamped forest, 13.324-



Figure 14. Pneumatophores at pools in Cheum Takong forest swamp (Loc. 9), 5.12.2019.



Figure 15. *Livistona* sp., a conspicuous flagship tree of Cheum Takong forest swamp., 5.12.2019.

339 N, 105.606-614 E, 112-230 m a.s.l., 5-6.12.2019.

The Cheum Takong interior was poor in Odonata, in spite of the abundance of water even in the dry season (the locals say there is a similar amount of water in the rainy season as well), most probably because of too scarce sunlight. The place looked as if specially created for *Copera vittata* and I did find them, but only 3 males (1 collected) and 1 immature (ghost stage) female (collected) during two days. The most frequent, although still scarce, damselfly was *Onychargia atrocyana* (Fig. 16), of which I found 8 males (3 collected) and 1 female (collected). Curiously, five of those males were found in one place, at adjacent branches and fronds in a considerable spot of sunshine. I also found a male and a female of *Archibasis viola*. Only three dragonfly species were found inside Choum Takong, all being libellulids preferring shady forest pools: a male of *O. chrysis*, a male of *Brachygonia oculata* and, between 2 and 3 p.m. on 5.12.2019, two teneral (on maiden flight)



Figure 16. A male of *Onychargia atrocyana* in Cheum Takong forest swamp (Loc. 9), 5.12.2019.

females of *Tetrathemis ?flavescens*.

There was a small (some 20x20 m) but waist-deep pool inside Cheum Takong (Fig. 17) at 13.3276 N, 105.6077 E, 112 m. Its water was filled with a curious, small semiaquatic Poaceae plant with very broad leaves and fuzzy panicles. Naturally this pool was a better Odonata habitat and they were quite abundant there, but not diverse. Damselflies were represented by many *Argiocnemis rubescens rubeola* (most immature red but also some blue mature males (Fig. 18); 2 ♂♂, 3 ♀♀ collected), besides a teneral female of *A. viola* was found there. Dragonflies were represented by several males of *Brachydiplax farinosa* (Fig. 6c), and one male of each *Nannophya pygmaea*, *N. fluctuans* and *O. chrysis*.

At the SE end of Choum Takong there is a small (ca 150 m long) and narrow sunny



Figure 17. A larger pool in Cheum Takong forest swamp (Loc. 9), 5-6.12.2019.



Figure 18. A male (above) and female (below) of *Argio-cnemis rubescens rubeola* at a larger pool (Fig. 17) in Cheum Takong forest swamp (Loc. 9), 5.12.2019.



Figure 19. A narrow open grassy swamp at Cheum Takong swamped forest (Loc. 9), 5-6.12.2019.

open area (at which we camped), crossed by an old road, occupied by a swamp with stagnant, turbid water filled with inundated fine grass (Fig. 19), 13.324-325 N, 105.605-606 E, 132 m a.s.l. It was similar to Cheum Thom (Loc. 6) but manifold smaller. Expectedly there were more Odonata there. Damselflies were represented by a male of *Ceragrion indochinense* (collected), a male of *A. pallidum* (collected), while net sweeping in grass provided three specimens (collected) of *Agriocnemis*, all of different species: males of *A. pygmaea* and *A. minima* and a female of *A. nana*. Dragonflies were represented by several *N. fluctuans* (immature with pale wings and mature with saturated wings), 2 males of *B. farinosa*, an immature male of *N. intermedia atalanta*, a male of *Nannophya pygmaea* (both collected) and a soaring male of *P. flavescens*. Also the guide captured a male of *Nesoxenia lineata* at its maiden flight.

A very old, incipiently overgrown but yet sunny, forest road goes along the NW side of Cheum Takong (with same the range of coordinates as for Cheum Takong itself, see above), which was examined on 6.12.2019. There I met a congregation of 5 individuals of *V. gracilis* (1 ♂ collected) and 2 immature (not yet red) males (1 collected) of *L. asiatica* perching on different dry branches of the same bush.

Discussion

The revealed fauna of Odonata of the Prey Long Forest area includes 60 species

and is summarised in Table 2. The fauna of Cambodia is herewith updated with *Copera chantaburii*. *Burmagomphus* sp. cf. *williamsoni* was represented by a single general female. It should be noted that in earlier dates of the same month, this species was found rather common below the waterfall on the Prey Thom (O'Dar, Siem Reap) River on the eastern Phnom Kulen Plateau in Siem Reap Province, situated westerly of the presently studied area. These data will be published and the species illustrated in a special paper devoted to the Odonata fauna of Phnom Kulen.

The deforested area in June provided 34 species and the forest in December 40 species (Table 2); these figures suggest that these species sets do not overlap much. June was a good season for lotic species, mostly for Gomphidae and Macromiidae, but the brevity of June examination and the degraded state of the examined terrain resulted in only two lotic gomphid species (*Burmagomphus* sp. and *M. albardae*) and one macromiid (*Macromia* sp.). It would be most interesting to study the Prey Long Forest itself, especially Cheum Takong, in June but this will be possible only when the road to Spong is constructed (after which this study should not be delayed, to be done before the forest is destroyed).

Table 2. Checklist of Odonata recorded in the two brief examinations of the Prey Long area as described above. Codes for subjective relative abundance are as follows: 1 – single individual found, 2 – few (2 to 5) individuals observed, 3 - moderately abundant (6-20 seen), 4 – abundant (~20-100); 5 – very abundant (hundreds).

		deforested area in June 2018					Prey Long Forest in December 2019			
Species	localities	1	2	3	4	5	6	7	8	9
1	<i>Vestalis gracilis</i> (Rambur, 1842)	-	-	-	-	3	1	2	4	2
2	<i>Heliocypha biforata</i> (Selys, 1859)	-	-	-	-	-	1	-	2	-
3	<i>Libellago lineata</i> (Burmeister, 1839)	-	2	2	-	3	-	-	-	-
4	<i>Lestes elatus</i> Hagen in Selys, 1872	-	-	-	2	-	-	-	-	-
5	<i>Aciagrion pallidum</i> Selys, 1891	-	-	-	-	-	-	-	-	1
6	<i>Amphialagma parvum</i> (Selys, 1876)	-	-	-	-	-	-	2	-	-
7	<i>Agriocnemis minima</i> Selys, 1877	-	-	-	-	-	2	-	-	1
8	<i>Agriocnemis nana</i> (Laidlaw, 1914)	-	-	-	-	-	1	-	-	1
9	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	-	-	-	2	-	-	1	-	1
10	<i>Archibasis viola</i> (Lieftinck, 1949)	-	-	-	-	-	2	-	-	2
11	<i>Argiocnemis rubescens rubeola</i> Selys, 1877	-	-	-	-	-	-	-	-	3
12	<i>Ceriagrion cerinorubellum</i> (Brauer, 1865)	-	-	-	-	-	4	1	-	-
13	<i>Ceriagrion calamineum</i> Lieftinck, 1951	-	-	-	2	-	-	-	-	-
14	<i>Ceriagrion indochinense</i> Asahina, 1967	-	-	-	3	-	-	-	-	-
15	<i>Ceriagrion olivaceum</i> Laidlaw, 1914	-	-	-	-	-	-	1	-	-
16	<i>Ischnura senegalensis</i> (Rambur, 1842).	-	-	-	-	-	-	1	-	-

		deforested area in June 2018					Prey Long Forest in December 2019			
Species	localities	1	2	3	4	5	6	7	8	9
17	<i>Pseudagrion australasiae</i> Selys, 1876	-	-	-	1	-	-	-	-	-
18	<i>Pseudagrion williamsoni</i> Fraser, 1922	-	2	-	-	-	-	-	-	-
19	<i>Copera chantaburii</i> Asahina, 1984	-	-	-	2	-	-	-	-	-
20	<i>Copera marginipes</i> (Rambur, 1842)	2	-	-	-	1	-	-	1	-
21	<i>Copera vittata</i> Selys, 1863	-	-	-	-	-	-	-	-	2
22	<i>Onychargia atrocyana</i> Selys, 1865	-	-	-	-	-	-	-	-	3
23	<i>Prodasineura autumnalis</i> (Fraser, 1922)	2	2	-	-	3	-	-	-	-
24	<i>Pseudocopera ciliata</i> (Selys, 1863)	-	-	-	-	-	2	1	-	-
25	<i>Burmagomphus</i> sp. cf. <i>williamsoni</i> Förster, 1914	-	1	-	-	-	-	-	-	-
26	<i>Ictinogomphus decoratus melaenops</i> (Selys, 1858)	-	-	-	2	1	-	-	-	-
27	<i>Macrogomphus albardae</i> Selys, 1878	-	-	-	1	-	-	-	-	-
28	<i>Macromia</i> sp.	-	-	-	-	1	-	-	-	-
29	<i>Acisoma panorpoides</i> Rambur, 1842	-	-	-	-	-	-	4	-	-
30	<i>Aethriamanta gracilis</i> (Brauer, 1878)	-	-	-	-	-	-	1	-	-
31	<i>Brachydiplax chalybea</i> Brauer, 1868	-	-	-	-	-	-	1	-	-
32	<i>Brachydiplax farinosa</i> Krüger, 1902	-	-	-	3	-	-	-	-	2
33	<i>Brachygonia oculata</i>	-	-	-	-	-	-	-	-	1
34	<i>Brachythemis contaminata</i> (Fabricius, 1793)	-	-	-	4	-	-	-	-	-
35	<i>Cratilla lineata calverti</i> (Förster, 1903)	-	-	-	2	2	-	-	-	-
36	<i>Crocothemis servilia</i> (Drury, 1770)	-	-	-	2	2	-	2	-	-
37	<i>Diplacodes nebulosa</i> (Fabricius, 1793)	-	-	-	1	-	1	4	-	-
38	<i>Diplacodes trivialis</i> (Rambur, 1842)	-	2	2	2	-	-	2	-	-
39	<i>Indothemis limbata</i> (Selys, 1891)	-	-	-	-	-	-	4	-	-
40	<i>Lathrecista asiatica</i> (Fabricius, 1898)	-	-	2	1	1	-	-	1	2
41	<i>Nannophya pygmaea</i> Rambur, 1842	-	-	-	-	-	4	4	-	1
42	<i>Nesoxenia lineata</i> (Selys, 1879)	-	-	-	-	-	-	-	-	1
43	<i>Neurothemis fluctuans</i> (Fabricius, 1793)	-	-	-	-	-	2	-	1	2
44	<i>Neurothemis fulvia</i> (Drury, 1773)	-	-	-	3	2	-	1	2	-
45	<i>Neurothemis intermedia atalanta</i> Ris, 1913	2	2	-	3	-	2	-	2	1
46	<i>Neurothemis tullia</i> (Drury, 1773)	-	-	-	-	-	-	1	-	-
47	<i>Onychothemis testacea</i> Laidlaw, 1902	-	2	3	-	2	-	-	-	-
48	<i>Orthetrum chrysis</i> (Selys, 1891)	-	-	-	2	-	-	2	1	2
49	<i>Orthetrum luzonicum</i> (Brauer, 1868)	-	-	-	-	-	1	-	-	-

		deforested area in June 2018					Prey Long Forest in December 2019			
Species	localities	1	2	3	4	5	6	7	8	9
50	<i>Orithetrum neglectum</i> (Rambur, 1842)	-	-	-	1	-	-	-	1	-
51	<i>Orithetrum sabina</i> (Drury, 1770)	-	-	-	2	1	1	3	1	-
52	<i>Pantala flavescens</i> (Fabricius, 1798)	-	-	-	3	-	-	-	-	-
53	<i>Potamarcha congener</i> (Rambur, 1842)	-	-	-	1	1	-	1	1	-
54	<i>Pseudothemis jarina</i> Förster, 1904	1	-	-	-	-	-	-	-	-
55	<i>Rhyothemis triangularis</i> Kirby, 1889	-	-	-	-	-	-	2	-	-
56	<i>Rhodothemis rufa</i> (Rambur, 1842),	-	-	-	-	-	-	3	-	-
57	<i>Tetrathemis ?flavescens</i> Kirby, 1889	-	-	-	-	-	-	-	-	2
58	<i>Tholymis tillarga</i> (Fabricius, 1798)	2	-	-	3	-	-	-	-	-
59	<i>Trithemis aurora</i> (Burmeister, 1839)	-	-	-	3	-	-	-	-	-
60	<i>Urothemis signata</i> (Rambur, 1842)	-	-	-	-	-	-	1	-	-
	total	5	7	4	24	12	13	23	11	17
		33					40			

The most interesting evergreen swamped forest of the Cambodian Lowland, represented by Cheum Takong and examined in December, provided only 17 species. However 5 of them were found only there: *A. rubescens*, *O. atrocyana*, *B. oculata*, *N. lineata* and *T. ?flavescens*. The three latter species are rare in Cambodia. Of species found there, *A. viola*, *B. oculata*, *N. lineata* and *T. ?flavescens* are generally Sondaic and represent the Sondaic faunal element of the Cambodian fauna (Kosterin & Kompier 2018). It was found that in Cambodia, the lowland rainforests floristically resemble the Malesian forests while montane rainforests are closer to those of India and China (Dy Phon, 1982); that indicates at the areas of origin of both biomes. Six odonate species found in Choum Takong, *A. viola*, *C. vittata*, *O. atrocyana*, *B. oculata*, *O. chrysis* and *Tetrathemis* spp., elsewhere also prefer shady lowland rainforests, including their swampy variants.

Unfortunately, *Tetrathemis* was represented with only two teneral females. They were captured in their maiden flight, still soft and allowed to harden more in captivity (Fig. 20). Curiously, they have quite large yellow lateral spots on S2-S7 but no trace of a double yellow dorsal spot on S7. This spot is present in two more common *Tetrathemis* species, *T. platyptera* Selys, 1878 and *T. irregularis* Brauer, 1878. Males of the third SE Asian species, *T. flavescens* Kirby, 1889 miss it, while female of this species is still unknown but probably also misses that spot. This species was considered a Bornean endemic until it was unexpectedly found (two males, of which one collected) in Koh Kong Province of Cambodia (Kosterin & Chartier 2019). Hence its presence in Prey Long is not excluded and I tentatively identify the two females from Cheum Takong as this species. Males are utmostly needed from the same place for final identification.



Figure 20. Teneral female specimens of *Tetrathemis ?flavescens* from Cheum Takong swamped forest (Loc. 9), 5.12.2019.

The only male of *A. viola* from Cheum Takong was bluish rather than violet and could be suspected for being *A. oscillans* (Selys, 1877) but it was obviously immature, while its cercus shape unequivocally suggests *A. viola* according to Lieftinck (1949)

Macromia sp. (Fig. 5) is the same species as the males photographed in the Cardamom Mountains by Gerard Chartier (Kosterin et al., 2012: fig. 11) and one male collected in Nan Province of Thailand by A. Muraki (2014) and denoted by him as *Macromia* sp3.; see also discussion in Kosterin (2015). This species is characterised by twin yellow spots inside the frons cleft and the yellow colour on S2 strongly split into the dorsal and lateroventral spots (Fig. 5).

I can't help but indicate two small errors in (Kosterin 2019) concerning the observation of *M. albardae* at Loc. 5a (see above). The name of the village is indicated as Srae Veal rather than Phneak Roleuk; actually these villages are contacting each other along Road 215 without a gap, but Srae Veal is the northern one while the dragonfly was observed 2 km southerly of the southern one, Phneak Roleuk. The date in the figure (Kosterin 2019: fig. 5) is incorrectly provided as "21 viii 2018", while correctly, "21 vi 2018", in the text.



Figure 21. Vann Sai, a local guide from Spong village, in Cheum Takong forest swamp (Loc. 9).

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