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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 (southeast) 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

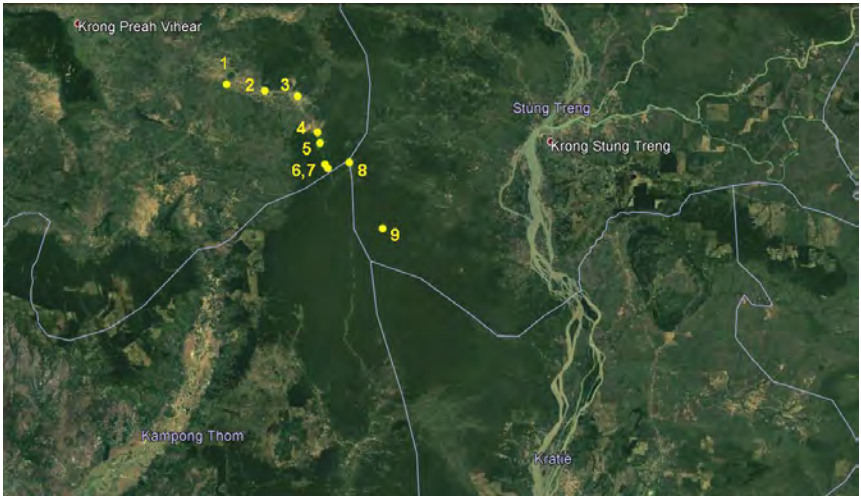


Figure 1. A Google Earth view on Prey Long Forest, with locaties studied (Loc.1 – 9; see the text) indicated.

that as soon as a road appears the forest is gone. Fore 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 attapt 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 evergreen 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 (vi) 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.

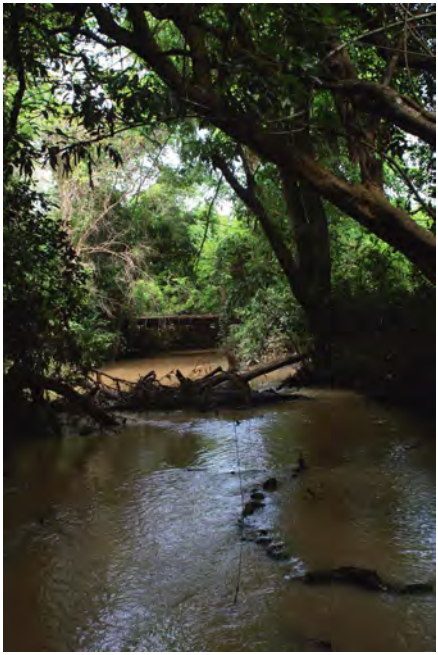
Table 1. Details of observations and collections of Odonata species made in the deforested Chey Saen District of Preah Vihear Province on 20-21.06.2018. 'Coll.' means 'collected', 'photo' – 'photographed in nature'. For explanations of localities see the text, for species authorities and dates see Table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

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

Species	Loc. 1	Loc. 2	Loc. 3	Loc. 4	Loc. 5
Cratilla lineata calverti	-	-	-	1 ♂ coll. at a big roadside pool, 1 more photo (Fig. 7)	several seen, at a road nearby
Crocothemis servilia	-	-	-	several seen	-
Diplacodes nebulosa	-	-	-	1 ♀ seen	-
Diplacodes trivialis	-	several seen	several seen	several teneral seen	-
Lathrecista asiatica	-	-	several seen	1 teneral ♀ photo (Fig. 8a)	1 ♂ seen
Neurothemis fulvia	-	-	-	many teneral seen, 1 mature ♂ seen at a road	several seen at a glade
Neurothemis intermedia atalanta	several seen	several seen	-	many subteneral seen	-
Onychothemis testacea	-	several ♂♂ seen	many ♂♂, several ♀♀ seen	-	several ♂ seen, 1 coll., 1 photo (Fig. 9), 1 ovipositing ♀ seen
Orthetrum chrysis	-	-	-	2 ♂♂ seen at roadside pools	-
Orthetrum neglectum	-	-	-	1 ♂ seen at a road pool	-
Orthetrum sabina	-	-	-	several seen	1 ♂ seen
Pantala flavescens	-	-	-	small swarms over glades	-
Potamarcha congener	-	-	-	many teneral seen, 1 teneral ♂ photo (Fig. 10), 1 teneral ♀, 1 ovipositing ♀ collected	1 ♂ photo
Pseudothemis jorina	1 ♂ seen	-	-	-	-
Tholymis tillarga	several ♀♀ seen	-	-	many seen (evening 20.06.2018)	-
Trithemis aurora	-	-	-	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 tenerals; 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 *Ceriagrion cerinorubellum* were frequent. Surprisingly, net sweeping over the grass did not provide *Agriocnemis* 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 *Pseudocopera 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 teneral 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 teneral 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*

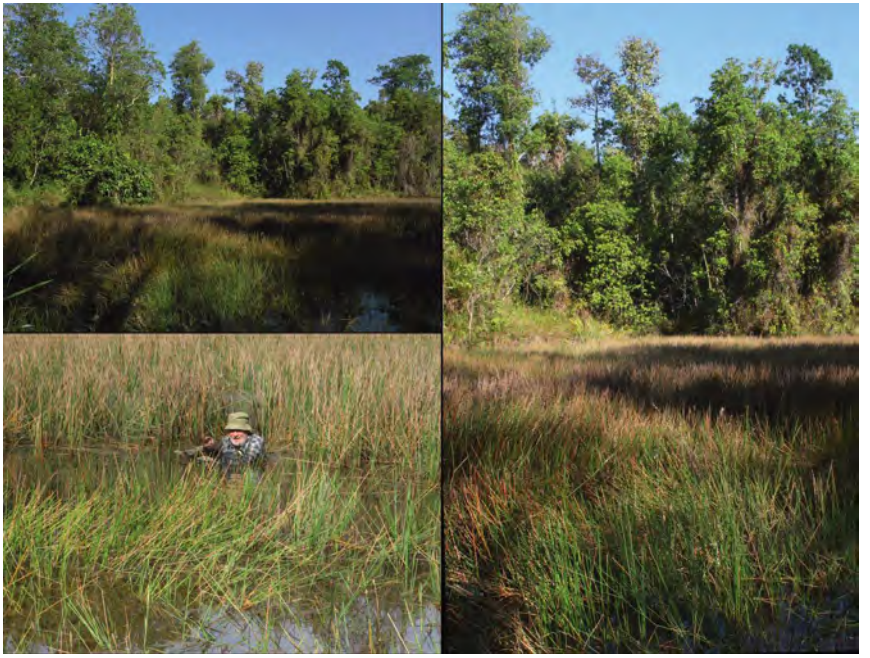


Figure 11. Lake Boeng Pes (Loc. 7).

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 plateaus (ca. 1200 m; Dy Phon, McDonald), occurs commonly here as both an upper- and understory tree, and often exhibits stilt 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 antenodals 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 *Pseudocopera 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 conspicuos 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 found 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 Argiocnemis 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 manyfold smaller. Expectedly there were more Odonata there. Damselflies were represented by a male of *Ceriagrion 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 teneral 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	*Vestalis gracilis* (Rambur, 1842)	-	-	-	-	3	1	2	4	2
2	*Heliocypha biforata* (Selys, 1859	-	-	-	-	-	1	-	2	-
3	*Libellago lineata* (Burmeister, 1839)	-	2	2	-	3	-	-	-	-
4	*Lestes elatus* Hagen in Selys, 1872	-	-	-	2	-	-	-	-	-
5	*Aciagrion pallidum* Selys, 1891	-	-	-	-	-	-	-	-	1
6	*Amphiallagma parvum* (Selys, 1876)	-	-	-	-	-	-	2	-	-
7	*Agriocnemis minima* Selys, 1877	-	-	-	-	-	2	-	-	1
8	*Agriocnemis nana* (Laidlaw, 1914)	-	-	-	-	-	1	-	-	1
9	*Agriocnemis pygmaea* (Rambur, 1842)	-	-	-	2	-	-	1	-	1
10	*Archibasis viola* (Lieftinck, 1949)	-	-	-	-	-	2	-	-	2
11	*Argiocnemis rubescens rubeola* Selys, 1877	-	-	-	-	-	-	-	-	3
12	*Ceriagrion cerinorubellum* (Brauer, 1865)	-	-	-	-	-	4	1	-	-
13	*Ceriagrion calamineum* Lieftinck, 1951	-	-	-	2	-	-	-	-	-
14	*Ceriagrion indochinense* Asahina, 1967	-	-	-	3	-	-	-	-	-
15	*Ceriagrion olivaceum* Laidlaw, 1914	-	-	-	-	-	-	1	-	-
16	*Ischnura senegalensis* (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	*Pseudagrion australasiae* Selys, 1876	-	-	-	1	-	-	-	-	-
18	*Pseudagrion williamsoni* Fraser, 1922	-	2	-	-	-	-	-	-	-
19	*Copera chantaburii* Asahina, 1984	-	-	-	2	-	-	-	-	-
20	*Copera marginipes* (Rambur, 1842)	2	-	-	-	1	-	-	1	-
21	*Copera vittata* Selys, 1863	-	-	-	-	-	-	-	-	2
22	*Onychargia atrocyana* Selys, 1865	-	-	-	-	-	-	-	-	3
23	*Prodasineura autumnalis* (Fraser, 1922)	2	2	-	-	3	-	-	-	-
24	*Pseudocopera ciliata* (Selys, 1863)	-	-	-	-	-	2	1	-	-
25	*Burmagomphus* sp. cf. *williamsoni* Förster, 1914	-	1	-	-	-	-	-	-	-
26	*Ictinogomphus decoratus melaenops* (Selys, 1858)	-	-	-	2	1	-	-	-	-
27	*Macrogomphus albardae* Selys, 1878	-	-	-	1	-	-	-	-	-
28	*Macromia* sp.	-	-	-	-	1	-	-	-	-
29	*Acisoma panorpoides* Rambur, 1842	-	-	-	-	-	-	4	-	-
30	*Aethriamanta gracilis* (Brauer, 1878)	-	-	-	-	-	-	1	-	-
31	*Brachydiplax chalybea* Brauer, 1868	-	-	-	-	-	-	1	-	-
32	*Brachydiplax farinosa* Krüger, 1902	-	-	-	3	-	-	-	-	2
33	*Brachygonia oculata*	-	-	-	-	-	-	-	-	1
34	*Brachythemis contaminata* (Fabricius, 1793)	-	-	-	4	-	-	-	-	-
35	*Cratilla lineata calverti* (Förster, 1903)	-	-	-	2	2	-	-	-	-
36	*Crocothemis servilia* (Drury, 1770)	-	-	-	2	2	-	2	-	-
37	*Diplacodes nebulosa* (Fabricius, 1793)	-	-	-	1	-	1	4	-	-
38	*Diplacodes trivialis* (Rambur, 1842)	-	2	2	2	-	-	2	-	-
39	*Indothemis limbata* (Selys, 1891)	-	-	-	-	-	-	4	-	-
40	*Lathrecista asiatica* (Fabricius, 1898)	-	-	2	1	1	-	-	1	2
41	*Nannophya pygmaea* Rambur, 1842	-	-	-	-	-	4	4	-	1
42	*Nesoxenia lineata* (Selys, 1879)	-	-	-	-	-	-	-	-	1
43	*Neurothemis fluctuans* (Fabricius, 1793)	-	-	-	-	-	2	-	1	2
44	*Neurothemis fulvia* (Drury, 1773)	-	-	-	3	2	-	1	2	-
45	*Neurothemis intermedia atalanta* Ris, 1913	2	2	-	3	-	2	-	2	1
46	*Neurothemis tullia* (Drury, 1773)	-	-	-	-	-	-	1	-	-
47	*Onychothemis testacea* Laidlaw, 1902	-	2	3	-	2	-	-	-	-
48	*Orthetrum chrysis* (Selys, 1891)	-	-	-	2	-	-	2	1	2
49	*Orthetrum luzonicum* (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	*Orthetrum neglectum* (Rambur, 1842)	-	-	-	1	-	-	-	1	-
51	*Orthetrum sabina* (Drury, 1770)	-	-	-	2	1	1	3	1	-
52	*Pantala flavescens* (Fabricius, 1798)	-	-	-	3	-	-	-	-	-
53	*Potamarcha congener* (Rambur, 1842)	-	-	-	1	1	-	1	1	-
54	*Pseudothemis jorina* Förster, 1904	1	-	-	-	-	-	-	-	-
55	*Rhyothemis triangularis* Kirby, 1889	-	-	-	-	-	-	2	-	-
56	*Rhodothemis rufa* (Rambur, 1842),	-	-	-	-	-	-	3	-	-
57	*Tetrathemis ?flavescens* Kirby, 1889	-	-	-	-	-	-	-	-	2
58	*Tholymis tillarga* (Fabricius, 1798)	2	-	-	3	-	-	-	-	-
59	*Trithemis aurora* (Burmeister, 1839)	-	-	-	3	-	-	-	-	-
60	*Urothemis signata* (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. ?flavenscens*. 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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Odonata of the great Lake Tonle Sap of Cambodia, as examined in 2017-2019

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Abstract

Lake Tonle Sap in NW Cambodia is the largest freshwater lake in Southeast Asia and one of the most productive freshwater ecosystems in the world, so its banks are a home for ca 1,5 million people. It serves as a natural reservoir of the excess water of the Mekong River and cyclically changes its area from 2,500 km^2 in May to 16,000 km^2 in October. Its banks are naturally occupied by temporarily inundated forest and scrub, at present mostly replaced by rice fields. The present day semiaquatic vegetation of the lake is to a large extent formed by invasive plant species. The hitherto existing data on Odonata of the lake are very scarce. The author briefly examined the bank and floodplain at the NW part of the lake in February/March 2017, June and November 2018 and December 2019. Five main localities studied are described and illustrated in detail. In total 41 odonate species of four families (22 in Libellulidae) were found. Most of them are common and widespread lentic species but *Macrogomphus phalantus* is a species hitherto known only by few specimens from swamped forests of Borneo and Sumatra; its Tonle Sap population was earlier described by the author as the subspecies *M. phalantus jayavarman* Kosterin, 2019. The earlier published report by Seehausen et al. (2016) of *Sinictinogomphus clavatus* (not found by the author) was a considerable extension of the known species' range to the south. Six species were found in all main examined localities and ten only in one of them. At any season at the lake immediate bank (that is water front at the lowest level), *Brachythemis contaminata* predominates overwhelmingly, *Orthetrum sabina* and *Crocothemis servilia* are numerous, two damselfly species, *Pseudagrion microcephalum* and *P. rubriceps*, invariably occur at floating vegetation (mostly water hyacinth), and *Trithemis pallidinervis*, *Urothemis signata*, *Rhyothemis phyllis*, *R. variegata* and *Tholymis tillarga* are common at bushes. *Agriocnemis nana, Ceriagrion praetermissum, Ischnura senegalensis, Macrogomphus phalantus, and Aethriamanta aethra* were occasionally met at the lake bank. Other 26 species were found, with different occurrence and quantity, on the lake floodplain. Variation of the male occiput coloration of *Amphiallagma parvum* is commented.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Lake Tonle Sap, Tonle Sap River, Mekong River, Siem Reap Province, Battambang Province, floodplain, temporarily inundated forest, *Amphiallagma parvum*

Figure 1. Lake Tonle Sap in a cosmic image at Google Earth.

Introduction

In its headwaters, the great Mekong River collects a big share of moisture brought by the summer monsoon to the Sino-Tibetan Mountains bordering from the east the huge Tibet Upland. Having left these mountains, the Mekong River flows to the south through southern China, provides the border between Myanmar and Laos, enters Laos, provides the border between Laos and Thailand, re-enters Laos, enters Cambodia and then enters Vietnam where falls to the Gulf of Siam of the South Chinese Sea. Being the seventh longest (4,350 km) river in Asia, with the catchment area of 795,000 km^2, it has been carrying a huge amount of sediments which made the sea to step back and formed the alluvial Cambodian Lowland which once was a bay of the Gulf, so that in its lower reaches Mekong has to pass through its own flat alluvium. This lowland is situated almost at the sea level and is so flat that Mekong at its higher levels fails to discharge all its water to the sea. The excess water is therefore redirected and stored in the natural reservoir of Lake Tonle Sap (Khmer 'big lake of fresh water') situated in the centre of the Cambodian Lowland (Fig. 1). It is connected with Mekong by the Tonle Sap River which joins it at the city of Phnom Penh, the capital of Cambodia (Fig. 1). During the summer monsoon, from May to September, this river flows from Mekong to fill Lake Tonle Sap. When the Mekong level decreases, the current reverses and the water stored in Lake Tonle Sap starts to flow back to Mekong, to be at last discharged to the sea. Hence the Tonle Sap River changes its direction twice a year, approximately in late May-early June and late October-early November, and the Cambodian New Year celebrated on 14-16th of April is associated with its spring turn (although currently takes place somewhat ahead of this). As a result, Lake Tonle Sap cyclically changes its length of 160 km, the area of 2,500 km^2 (Fig. 2), the

volume of 1 km^3, and the average depth of 1 m in May to a length of 250 km, the area of 16,000 km^2, the volume of 80 km^3, and an average depth of 6-9 m in October (Mekong River Commission 2005). However, Eddie Smith (pers. comm.) informed me that in recent decades the lake seasonal maxima became smaller than this. The lake is also fed by its NW tributary, the Stung Sangkae (or Sankar) River. Sounding has shown that the lake bottom is perfectly flat without any relief, with the deepest point situating just 2.4 m above sea level (E. Smith, pers. comm.). In these respects, Tonle Sap is somewhat analogous to the Amazon River or even the epicontinental seas of the Mesosoic.

Figure 2. Lake Tonle Sap at its high level inundating the flatland surrounding its NE end at Kampong Chhnang Town. Photos by Eddie Smith.

Nevertheless it is fairly young, as formed just 6-8 thousand years ago, that is rather shortly after the Holocene onset, obviously following the increase of humidity at higher latitudes and the volume of the Mekong flow.

Tonle Sap is the largest freshwater lake in Southeast Asia and one of the most productive freshwater ecosystems in the world. Like the Nile in Egypt, this huge fluctuating water body full of fertile sediments has always been the source of living resources (Fig. 3), through rice farming and fishing (the latter practiced by Cham rather than Khmer people), for 1.2-1.3 million people populating its banks (but in the fishing season lasting from October to June, their number increases to 1.4-1.6 million). This was a prerequisit of the rise of the famous Angkorian Civilisation in IX century, whose capital was the largest urban centre in the world in XI-XIII centuries. At present the water surface (Figs 4-5), as well as seasonably flooded forest, is adorned with numerous large, arrow-shaped fish traps and speckled with floating villages (Figs 6-7). On the surrounding flatland, several embankments go parallel to the water front, so that when the lake shrinks, shallow water (partly supplied also with channels from outside the lake) is retained at their inland side and is subsequently used for watering rice field at their lake-faced side. As a rule these shallow 'reserves'

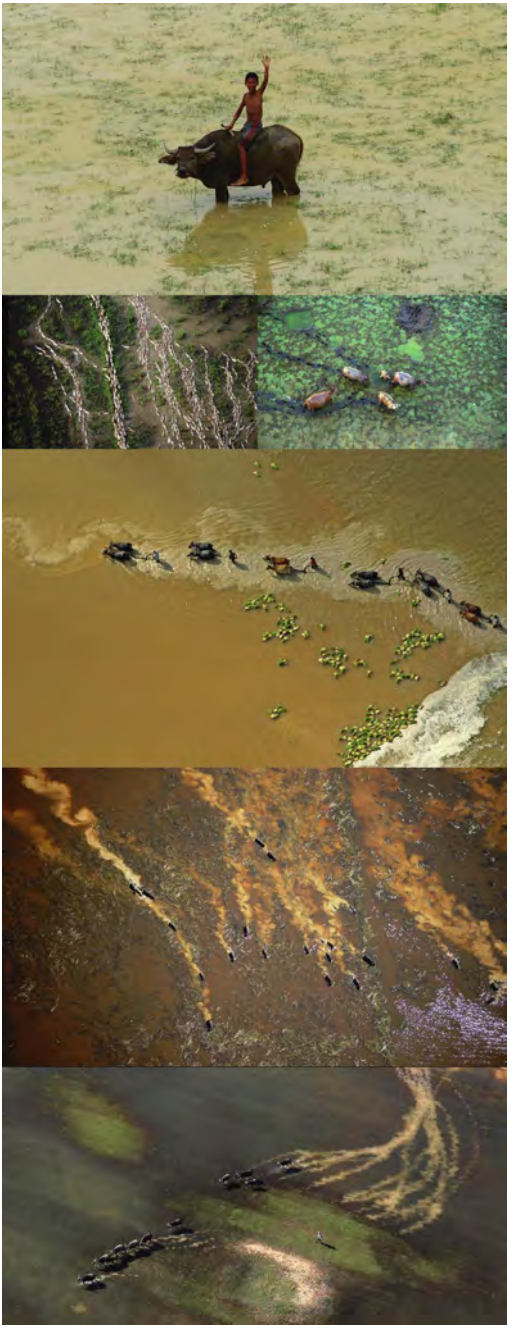


Figure 3. Water buffaloes and ducks (left near the top) in shallow waters at the Lake Tonle Sap banks. Photos by Eddie Smith.

are covered with thick but low temporarily inundated scrub, but at least a huge area (some 3 x 2 km) SW of Siem Reap City, bordered by a road embankment going from Phnom Krom village to Sambuor village, is a deeper and permanent lotus/water hya-

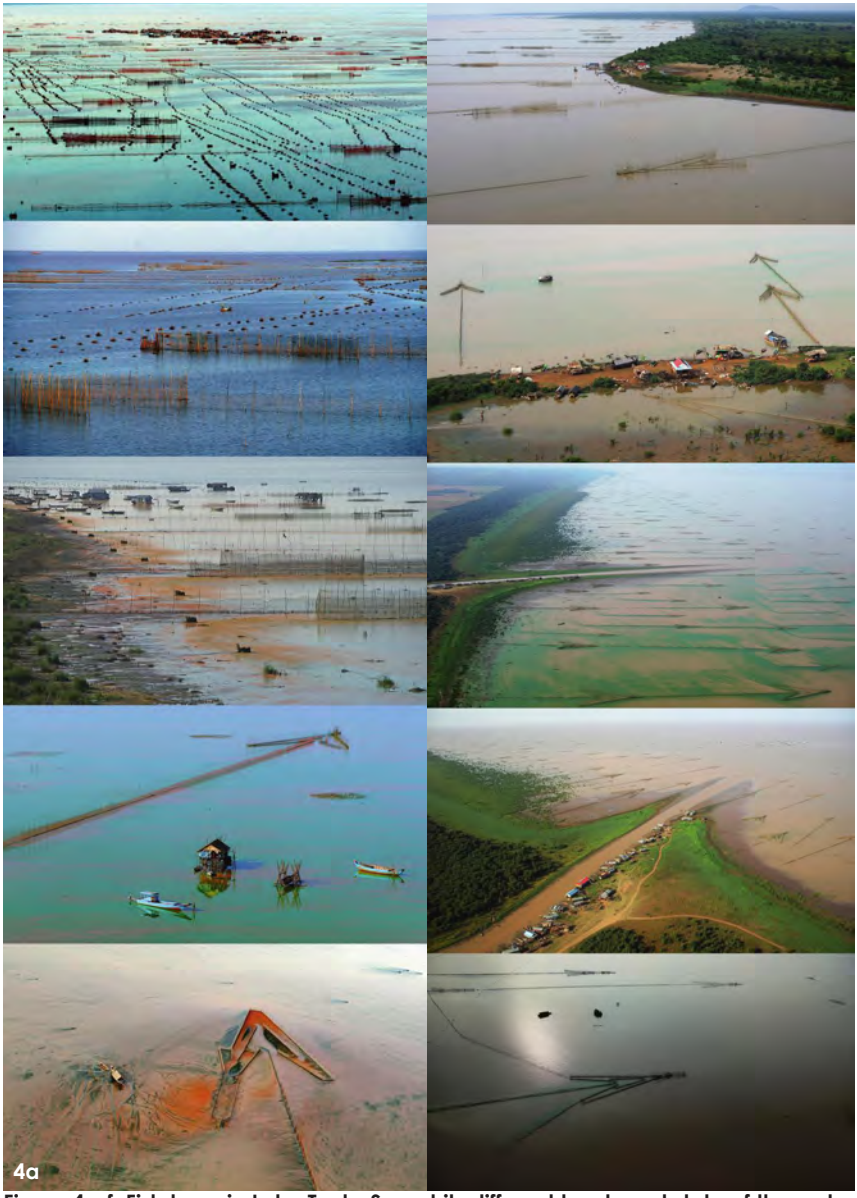


Figure 4a-f. Fish traps in Lake Tonle-Sap at its different levels and state of the water. Photos by Eddie Smith.

cinth swamp. This wetland-creating practice provides good habitats of many wetland birds, first of all Asian openbill storks (*Anastomus oscitans* (Boodayert, 1783) (Fig. 8). Beside these regular flat reserves formed by dams parallel to the lake bank, small deeper and roundish water reserves are scattered here and there (Fig. 9); these are mostly illegal and are regularly destroyed by the local authorities.

The natural vegetation of Lake Tonle Sap banks was the peculiar, temporarily flooded forest composed mostly of *Barringtonia acutangula* (L.) Gaertn., *Dyospiros* sp. and *Terminalia cambodiana* Gagnep. (L. Everaere pers. comm.). This forest has been depleteds because of human overexploitation lasting for at least one thousand year but remains at the lowermost reaches and the mouth of the Sangkae River, along the southern bank and in certain refugia on the northern bank, e.g. in popular touristic sites of the villages of Kampong Pluk and Kampong Khleang (see relevant sections below). In the remote past, the lake banks would have abounded in crocodiles, elephants, rhinos, wild water buffaloes etc. but at least a thousand years of thriving human civilisation (that is lasting for a considerable part of the lake age) left no room for them. Yet the lake is still almost the last refugium of the Mekong Giant Catfish (*Pangasianodon gigas* Chevey, 1931), one of the largest freshwater fishes in the world.

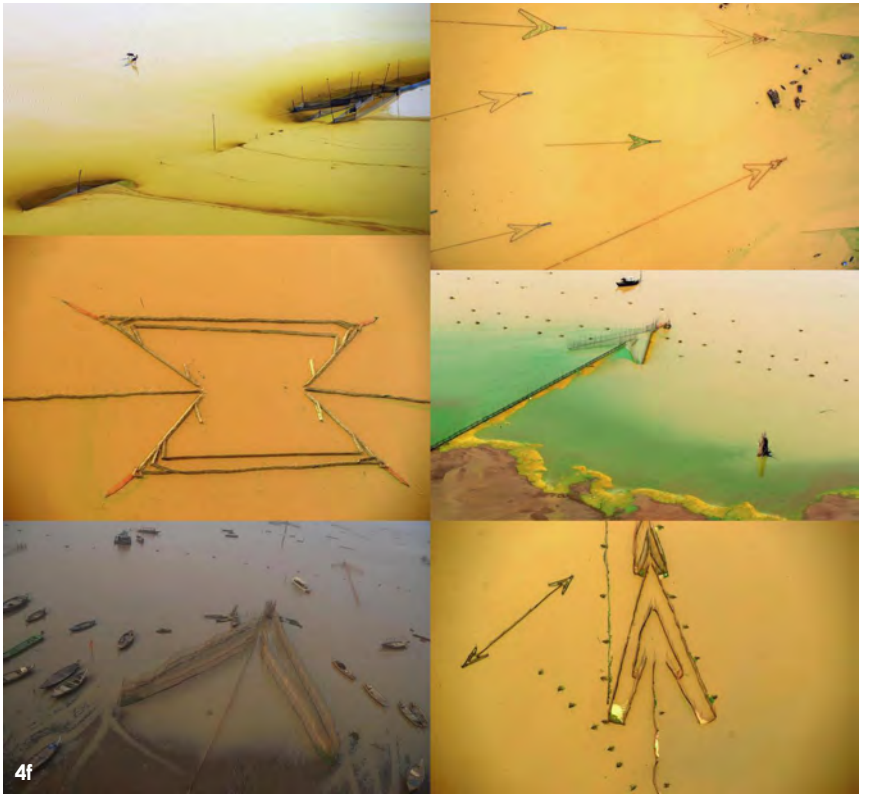
However special the Tonle Sap ecosystem is, it is currently far from its pristine state not only because of deforestation, extermination of large animals and overexploitation if natural resources but also, if not mainly, due to the prolonged history of alien species invasion. Thus, large areas of the shallow water surface in inundated forest and scrub is covered by carpets (Fig. 10) of Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms), an invasive species of the Amazonian origin, which produces enormous biomass and comprises an overwhelming majority of floating vegetation. Among the water hyacinth, rosettes are frequent of the Water Cabbage (*Pistia stratiotes* L.), another species of probably American origin. The inner zone of seasonably flooded scrub facing the lake bank is largely formed by the 'Giant Sensitive Tree' (*Mimosa pigra* L.),

a tall semiaquatic spiny bush of a Mexican origin, and side-by-side with it Giant Cane (*Arundo donax* L.) emerges from water, whose indigenous range probably was in the Mediterranean and Near East, while both are interspersed with floating water hyacinth (Fig. 11). Hence most of the bank vegetation below tree level is currently formed by alien species. In low water season, the once inundated tree branches up to 3-4 m above the emerged ground are speckled by dry dead colonies of two species of bivalve mollusks from the family Mytilidae (Fig. 12), *Synomytilus harmandi* (Rochebrune, 1882) and *Limnoperna fortunei* (Dunker, 1856), of which the former is the Mekong catchment endemic while the latter is thought to have invaded Indochina from

China (Morton & Dinesen 2010). The actual alteration of the Tonle Sap ecosystem by invasive species may be much more profound than is noticeable by superficial observations.

Also there is a furiously debated plan (financed by Chinese money) to construct a large hydropower dam across Mekong in Kratie Province. It would regulate Mekong and is expected to stop the Tonle Sap level cycle, thus destroying its unique ecosystem and depriving about million people from living resources.

Surprisingly for such a unique and at the same time imperiled wetland, hitherto there was no special study of Odonata of Lake Tonle Sap, probably because of poor faunistic expectations. Occasional data were published by Benstead (2006), Roland & Roland (2010), Roland et al. (2011) and Seehausen et al. (2016). All these authors visited the same famous birdwatching site Prek Toal in the Sangkae River lowermost reaches (13.24 N, 103.66 E), accessible by boats. Benstead (2006) twice visited this site in early low water season (16.03.2005 and 17.03. 2006) to find "up small forested creeks in the flooded forest" two species, *Agriocnemis pygmaea* and *Acisoma panorpoides* (for



the authorities of all species mentioned in the text see Table 1). On 27.06.2003 (late low water season), Jérôme Constant and Koen Smets collected there 11 other species *Agriocnemis minima, Ceriagrion auranticum, Ischnura senegalensis, Sinictinogomphus clavatus, Brachythemis contaminata, Crocothemis servilia, Neurothemis tullia, Pantala flavescens, Rhyothemis phyllis, R. variegata* and *Urothemis signata* (Seehausen et al. 2016). On 16.02.2010 (also early low water season) Roland & Roland (2010) visited the same site to find two species (one added), *B. contaminata* and *Diplacodes trivialis*. On 16.22.2010 (high water season) the Roland famliy revisited it as more focused on Odonata (Roland et al. 2011) and found seven species (adding four): *A. minima, Pseudagrion rubriceps, Ictinogomphus decoratus, Acisoma panorpoides, B. contaminata, Tholymis tillarga* and *Trithemis pallidinervis*. So, 18 species of Odonata have been reported for Lake Tonle Sap before my visits, and only for one place. The report of *S. clavatus* by (Seehausen et al. 2016) was the first and remains the only for Cambodia.

Hence, Cambodia appeared to harbour a gem of a huge and peculiar wetland as yet largely unexplored with respect to Odonata, which could not be missed in my odonatological studies of Cambodia. My expectation ranged from a handful of widespread 'boring' lentic species to something fitting the lake's uniquity. I examined the lake's

northern bank four times, in the beginning of the low water season (ca 20% of the maximum level) in February/March 2017, at the end of the low water season (10% of the maximum level) in June 2018, at the end of the high water season in November 2018 (ca 80% of the maximum level, ca 01.5 m below it) and a rather intermediate but already decreased level (ca 30%) in December 2019. On these four visits, 12 full days were in total devoted to the lake and its immediate surroundings (Fig. 13). The results were somewhat intermediate to the two expectation options: a handful of widespread lentic species plus something unexpectable: a new subspecies of *Macrogomphus phalantus* Lieftinck, the species previously thought to occur in swamped forests of Borneo and Sumatra and to be very rare (Kosterin 2019a). These results are outlined below, in spite of inevitable difficulties of describing dragonfly communities of fluctuating habitats. Because of this, below I first make an attempt to do this in a locality-wise order, and provide a checklist of species found with reference to localities at the end of the paper. I include only the data from seasonably flooded areas near the lake (Fig. 13) and

Figure 5. Fish traps at banks of Lake Tonle-Sap at the low water season at its different levels and state of the water. Photos by Eddie Smith.

Figure 6. Cham fishermen floating villages in Lake TonleSap.

do not mention those from firm lands around, like the Angkorian temple area, which will be considered elsewhere.

These studies were greatly facilitated by Eddie Smith, a microlight pilot from Siem Reap, who has been flying above the region for already 17 years and who shared a great amount of useful information about it, offered an aerial overview of the study area and generously granted a permission to use his aerial photos to illustrate this paper (his photos are indicated in captions, others are by the author).

Methods

The lake periphery was accessed by a small motorcycle Honda Dream C125 or 'tuk-tuk' (a wagon driven by a motorcycle of the same type) via roads, sometimes going along embankments surrounded by water. In the high water season, the stilted villages were accessed by big motor boats (Fig. 14, above) while the inundated forest was accessed by flat-bottomed rowing boats driven by local boatmen or boatswomen (Fig. 14, below), also used in Preak Toal village environs in intermediate season. Common species were recorded by sight, some specimens were collected and stored in

the author's collection and in the Naturalis Biodiversity Center, Leiden, the Netherlands. Photographs of landscapes and Odonata (in purely natural conditions, never posed) were taken with Olympus Camedia C8080 or Canon EOS 350D cameras with a Sigma AF 24-70 mm F2.8 EX DG MACRO lens. Coordinates are provided in the decimal degree format. They were recorded by Garmin eTrex H personal GPS navigator but the provided ranges for the areas actually examined were revised using Google Earth. The elevations are not provided since all they were several metres above sea level while neither the GPS navigator nor Google Earth are precise enough to provide correct fine values. The dates are provided in the dd.mm.year format. The photographs of odonate made during this study have been submitted to iNaturalist.com (see the user @oleg_kosterin and the project 'Odonata of Cambodia'). The material is delivered according to the following principles (if appliable): (i) localities from east to west (but

Figure 7. Cham fishermen floating villages in Lake Tonle-Sap. Photos by Eddie Smith.

with the westernmost Phnom Penh, which is not actually at the lake, added at the end); (ii) sublocalities from the lake bank towards inland; (iii) dates from the late high water season (November) to the late dry season (June) and then to intermediate season (December).

Localities

Kampong Khleang (KK)

Kampong Khleang is a big stilted fishing village (Fig. 15) with some 30 thousand inhabitants (Kampong Khleang Commune, Soutr Nikom District, Siem Reap Province) situated at the lake NEE bank at the mouth of the former ancient canal going from the Phnom Kulen Mts to the lake, once used for irrigation and rock transportation. Presently the canal exists only downstream the village and only its former walls are still noticeable upstream. An area downstream the village is occupied by seasonably flooded forest (Figs 16-17). The canal further enters a 23 km long lagoon (seen in Fig. 13) separated from the main lake by a forested spit. Examined only on 07.11.2018 in the late high water season. In sum 11 odonate species registered.

KK1. (9 species) The inundated forest near the lake-faced village margin (Figs 16-17). 13.093-095 N, 104.111-120 E. The trunks of rather low trees were deeply inundated up to their crowns, which were densely braided with the winding Ivy Woodrose (*Merremia hederacea* (Burm. f.) Halier f.; Concolvulaceae) with small yellow flowers. Actually this represented the most widespread type of the seasonably flooded forest at Lake Tonle Sap.

Figure 8. Asian openbill storks at Lake Tonle-Sap. Photos by Eddie Smith.

Figure 9. The Sangkae River/Lake Tonle Sap joint floodplain as seen from the plane Siem-Reap – Bangkok on 15.12.2019, with many small roundish reserves and the road from Mukh Paen village seen. Collection points MP1, MP2 and MP3 are indicated (see the text).

Broken ends of lower branches in shade were mostly covered with some grey sponges but no bivalve colonies were seen. Open areas of water were mostly covered with large matts of *Persicaria* sp. (with long stolones and erect, narrow white inflorescences), interspersed with water hyacinth and water cabbage (Fig. 18). At these matts, *Pseudagrion microcephalum* and *P. rubriceps* occurred at similar low numbers (one male of each collected); among them one female of *Agriocnemis nana* was collected. Dragonflies were represented by *B. contaminata* and *O. sabina* (frequent at any vegetation type but not numerous); one male *U. signata* and *T. pallidinervis* perched on tall dry branches of *Mimosa pigra*, and 2-3 individuals of *R. phyllis* fluttering over the water. Quite often *T. tillarga* were seen in their characteristic, swift and erratic flight in deep shaded gaps between inundated trees.

KK2. (6 species) A road embankment by the canal inside the village, at the pagoda. 13.125-126 N, 104.121-122 E. Houses and shrubs on the embankment; the water almost entirely covered with water hyacinth leaving scarce openings, some patches of *Persicaria* sp. and Elephant Eear (*Colocasia* sp. or *Alocasia* sp.), inundated shrubs (mostly *M. pigra*) and solitary low trees (Fig. 19). Numerous *B. contaminata*, quite a few *C. servilia*, again one perching male of each *U. signata* and *T. pallidinervis*, one flying *P. flavescens*.

Kampong Pluk (KP)

Kampong Pluk (or Kampong Phluk) is a stilted village (Figs 20-22) of about 3 thousand people (Kampong Phluk Commune, Prasat Bakong District, Siem Reap Province) which is the closest to the city of Siem Reap and most popular among tourists, as a curious settlement and because of retaining nearby the largest area of seasonably flooded forest. Alike Kampong Khlaeng, Kampong Pluk is situated near the mouth of the ancient, ca 36 km long and a thousand years old, Roluos Canal starting at the Phnom Kulen Plateau in the north-east. Unlike the canal at Kampong Khlaeng, Roluos Canal exists until present (Figs 23). It enters Lake Tonle Sap immediately, without any lagoon. In 14.5 km N of Kampong Pluk, Roluos village is situated, with Bakong, Lolei and Preah Ko Temples, where Hariharalaya, the first capitol of the Angkor Empire, was established by its founder Jayavarman II around the first years of IX century. The area was examined in the early low level season, late low level season and late high level season. In sum 28 species registered.

Figure 10. Carpets of water hyacinth: above - fresh in a swamp 2 km NE of Phnom Krom Hill (locality PK1, see below, 3.11.2018 and 12.12.2019): below - dry in a temporary fishing village between Phnom Krom and Kampong Pluk (locality WF2, see below, 13.06.2018).

KP1. (15 species) The seasonably flooded forest between the village and the mouth of the Roluos Canal. 13.195-204 N, 103.971-975 E. The forested area starts at the village, continues for 1 km at both sides of the canal to its mouth, has a rhomboid shape and is 650 m in its broadest place but then again extends along the very lake bank. It was studied only at the western side of the canal. At its SW side the forest was obviously replanted since young trees are disposed in rows, elsewhere it looks pretty natural, and very weird because of rather tall and very thick trees with twisted trunks and branches. I did not observe this forest type elsewhere (although there may be further areas of similar forest to the east of the village, as may be judged from the air). At the forest margin facing the lake open bank as well as its western margin, lower trees appear similar to those at Kampong Khlaeng. Further to the west they are replaced by scrub (with a big share of *M. pigra*) thickly covered by ivy woodrose.

At the high water season the trees were inundated up to the branching crowns (Fig 24a-b). A family of crab-eating maca-

Figure 11. Vegetation at the Sangkae River mouth (close to Loc. PT) is formed by three alien species of different origin: Arundo donax **(cane)**, Mimosa pigra **(scrub) and** Eichhornia crassipes **(floating). 10.12.2019.**

ques (*Macaca fascicularis* Raffles, 1821) wandered near the village over the tree crowns and a pavement made through (Fig. 25), waiting for boated tourists to feed them. The water was slightly greenish turbid. The floating vegetation was represented

Figure 12. Dead colonies of small mussels on branches of trees of temporarily inundated forest at the northern bank of Lake Tonle Sap, at its low level season, at Kampong Pluk village (24.02.2017, above, and 15.06.2018, below).

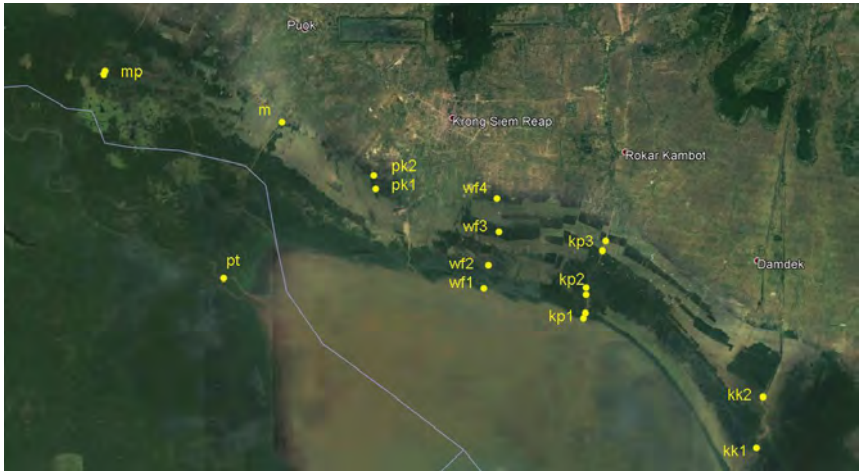


Figure 13. Disposition of sited examined at Lake Tonle-Sap in 2017-2019 shown on a Google Earth cosmic image. For explanations see the text.

Figure 14. Big boats bound to Kampong Pluk village at the high water season (2.11.2018) (top) and a small flat-bottomed boat used for examining of the Prek Toal area (10.12.2019) (bottom).

exclusively by water hyacinth forming small patches under the forest and at the lake very bank and large matts at open places among trees. Odonates were searched for on 02.11. 2018, at 9:40-12:00 a.m.; 11 species were found. In the shade of the forest canopy they were represented by rather abundant *B. contaminata* (near water hyacinth patches and emerging branches), not infrequent *O. sabina* (at branches) and *P. rubriceps*, few *P. microcephalum* and one female (collected) of *Ceriagrion praetermissum* (the damselflies kept to water

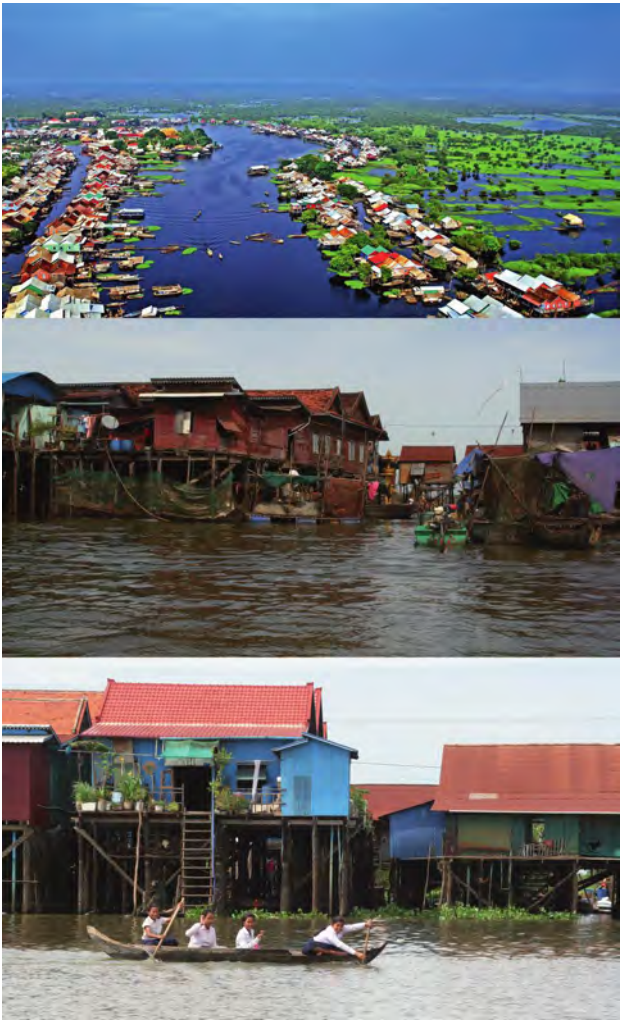


Figure 15. The stilted village of Kampong Khlaeng. Top photo by Eddie Smith, middle and bottom photos by the author.

hyacinth). A male of *T. tillarga* (collected) was startled from a tree branch. At sunny areas of open water at the western margin of the forest (Fig. 26), odonates were more abundant. *O. sabina* and *P. rubriceps* remained most numerous and *P. microcephalum* were quite frequent but *B. contaminata* became few. There were several females of *C. servilia* and one bright male of *U. signata* (at a water hyacinth patch). At larger open water areas several *T. pallidinervis* perched on tall stems of *M. pigra* (both sexes photographed, Fig. 27). Above open water areas at the tall forest margins, quite a few *R. variegata* and less frequent *R. phyllis* fluttered and quite many *T. tillarga* were flying (in spite of the sun) along trees at a considerable height.

Figure 16. Lower inundated forest at Kampong Khlaeng village (loc. KK1) at the high water season (7.11.2018).

Figure 17. Taller inundated forest at Kampong Khlaeng village (loc. KK1) at the high water season (7.11.2018).

When examined at the early low water season (24.02.2017, at 12 a.m. – 2 p.m.), there was no water in the forest, a bush understory was released from water but the ground was muddy and sticky and had scarce grass (Fig. 28). Odonates were almost absent from the forest: I only managed to startle two females of

Figure 18. Floating patches of Persicaria **sp.,** Pistia stratiotes **and** Eichhornia crassipes, **Taller inundated forest at Kampong Khlaeng village (loc. KK1) at the high water season (7.11.2018).**

Figure 19. Inundated open scrub (mostly Mimosa pigra**) and open tree stand at the canal in Kampong Khlaeng village near the pagoda (loc. KK2) (7.11.2018).**

T. tillarga and to find two males of *P. rubriceps* at bushes by the canal bank (1 photographed). Closer to the lake the mud became deep and sucking and reached a knee depth, then muddy green water appeared and became deeper so that a knee deep mud was gradually replaced with a knee deep water at the forest margin facing the lake open surface, which actually marked the lake bank (Fig. 29 below). The tree branches were speckled with dead colonies of small mussels. Along the bank. *B. contaminata* was extremely abundant, among which *O. sabina* were frequent. The shrubs at the western forest margins (Fig. 30) were covered with thick layers of dry water hyacinth and alive and dead ivy woodrose which formed mounds upon which I could climb. Numerous *T. tillarga* were startled from these bushes and started to fly along them, sometimes by several at once, but seemed to be all females (at least I did not see a single red mature male) There were quite many flying *R. phyllis* and *R. variegata*,

Figure 20. The stilted village of Kampong Pluk at the early low water season (24.02.2017).

Figure 21. The stilted village of Kampong Pluk at the high water season. Photos by Eddie Smith.

Figure 22. The stilted village of Kampong Pluk at the high water season (02.11. 2018).

Figure 23. The Roluos Canal at Kampong Pluk village at the high (left; photo by Eddie Smith) and low (right, photo by the author) water seasons.

which at ca 2 p.m. formed a big swarm on an opening among low trees. Above them, at the height of 3-9 m, about a dozen of *Epophthalmia* ranged, obviously in trophic flight (a later finding and general occurrence in the area suggested these were *E. frontalis*).

At the end of the low water season (15.06.2018, at 8:45 a.m. – 2 p.m.) the ground in the seasonably flooded forest (Fig. 31) was dry and firm but the bank and the closest to it part of the scrub at the western forest margin were just starting to be inundated with a very shallow and quite clear, only slightly turbid water (the bottom was still firm). There were many dragonflies but strikingly not a single damselfly. The dragonflies were mostly associated with the bank of the canal, which still had a turbid reddish water, perhaps because of too heavy motor boat traffic (Fig. 32). There were very many *B. contaminata* (especially at and near water), several ranging territorial males of *E. frontalis* (1 collected), 1 territorial male of *Ictinogomphus decoratus melaenops* (photographed), 2 individuals of *O. sabina* and, surprisingly for such an eutrophic water body, at least 3 males (flying above the water, rarely perching on prominent stems; 1 collected) and a female (ovipositing around a stick shortly protruding from the water 1 m off the bank) of *Pseudothemis jorina*. Under the forest canopy, resting but cautious *T. tillarga* (including mature males, one photographed – Fig. 33) became more frequent closer to the lake.

The waterfront was rimmed with a 20-30 m broad stripe of tall annual bulrush *Actinoscirpus grossus* (L.f.) Goetgh. & D.A. Simpson, which quickly rises around the lake at the end of the dry season (Fig. 29 above). At the time of examination it was already

Figure 24a-b. The forest near Kampong Pluk village (Loc. KP1) inundated by the high Tonle Sap water (02.11.2018).

inundated by shallow rising water. *B. contaminata* expectedly occurred there in great numbers but others were scarce: I met two *O. sabina* (Fig. 34) and one *R. phyllis* and, quite unexpectedly, a not yet fully mature, still yellow-and-black male of *Aethriamanta aethra*, which showed high fidelity to its perch of a protruding branch (Fig. 35a).

Behind (at the NNW margin of) the forest strip going along the lake bank from the canal mouth, there was a kind of a broad 'meadow' with bushes and low trees, being inundated by very shallow water advancing as I watched (this area was studied at 13.195-204 N, 103.971-975 E, some 70-90 m off the lake bank). There were less *B. contaminata*, few *R. phyllis* et *variegata* and two old females of *C. servilia* (Fig. 36c). But above these, there was an incredible surprise: quite a number of big and impressive *Macrogomphus phalantus jayavarman* (males and a posttteneral female) (Fig. 37), some

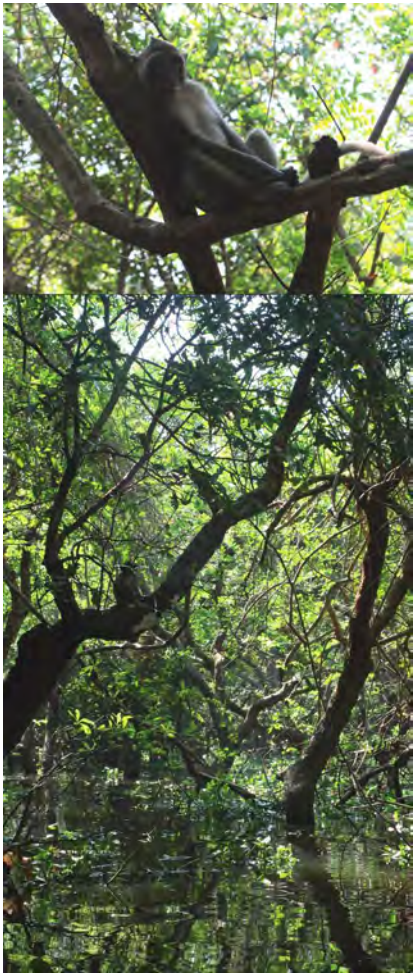


Figure 25. Crab-eating macaques in the inundated forest near Kampong Pluk village (02.11.2018).

Figure 26. Open areas with sparse inundated trees between Kampong Pluk village and Lake Tonle Sap bank (Loc. KP1) at the high water season (02.11.2018).

of which comprised the type series of this taxon (Kosterin 2019a). They sat on vertically hanging tree branches and herbaceous lianas (once two sat on one stem), rarely on prostrate branches, mostly in shade but sometimes under direct sun. Some of them

Figure 27. A male (left) and female (right) of Trithemis pallidinervis **in open areas in inundated forest between Kampong Pluk village and Lake Tonle Sap bank (Loc. KP1) at the high water season (02.11.2018).**

Figure 28. The seasonably flooded forest near Kampong Pluk village (Loc. KP1) in the early low water season (24.02.2017).

Figure 29. The Lake Tonle Sap N bank 1 km S of the margin of Kampong Pluk village (Loc. KP1): below – still inundated in the early low water season (24.02.2017); above – overgrown with annual Actinoscirpus grossus **and started to be inundated again in the late low water season (15.06.2018).**

Figure 30. Scrub covered with ivy wood-rose at the western forest margin near Kampong Pluk village (Loc. KP1) in the early low water season (24.02.2017).

were found deeper in the forest. They were not very cautious: when startled, they flew for some dozen of metres and sat again. Curiously, not a single one was seen at the canal banks. Most probably, these big dragonflies emerged immediately from the lake, although I did not see any exuviae.

KP2. (17 species) The village environs; examined at its western margin at the pagoda, 13.2090 N, 103.973 E, 01.5 km NNE of the lake bank, and its northern end, 13.220 N, 103.974 E, 2.8 km from the lake. There was patchy scrub,

Figure 31. The seasonably flooded forest near Kampong Pluk village (Loc. KP1) in the late low water season (15.06.2018).

Figure 32. The lowermost reaches of the Roluos Canal crossing the seasonably flooded forest in southern vicinities of Kampong Pluk village (Loc. KP1) in the late low water season (15.06.2018), at that time inhabited by Ictinogomphus decoratus, Epophthalmia frontalis **and** Pseudothemis jorina**.**

at the pagoda also open tree stand (Fig. 38), both trees and bushes being thickly covered with ivy woodrose, and scarce giant cane. This area was examined only in the low season, since in the high season it is inundated by deep water. In the early low season (24.02.2017, at 11:30-12 a.m. and at 3-3:30 p.m. at the pagoda) the trees and bushes were still green while the ivy woodrose covering them partly green and partly

Figure 33. A male of Tholymis tillarga **in shade of the seasonably flooded forest at Kampong Pluk village (Loc. KP1) in the late low water season, 15.06.2018.**

Figure 34. A male of Orthetrum sabina **eating a male of** Brachythemis contaminata **on a dead, dry colony of small mussels at the N bank of Lake Tonle Sap 1 km S from the margin of Kampong Pluk village (Loc. KP1) in the late low water season, 15.06.2018.**

Figure 35. A not fully mature male (a), mature male (c) and a female (b) of Aethriamanta aethra **in the late low water season: a - at the N bank of Lake Tonle Sap 1 km S from the margin of Kampong Pluk village (Loc. KP1), 15.06.2018; b and c – at a big lotus swamp 3 km NW of the Phnom Krom hill (Loc. PK1), 18.06.2018 .**

dry. Among trees and bushes, various pools with yellow water remained, and also bigger ponds near the pagoda. All they were partly covered with floating patches of water hyacinth, fresh-green with some flowers. Unlike in the inundated forest at that time, damselflies were not infrequent there, as represented by *I. senegalensis* and *Agriocnemis*, a number of which I checked in hand and found only *A. minima* at the pagoda and *A. pygmaea* at the village northern end. Dragonflies were representing by fluttering *R. phyllis* (Fig. 39) and *R. variegata* (quite frequent), soaring *P. flavescens* (few), perching on tall sticks *I. decoratus* (3 ♂♂ seen, 1 photographed – Fig. 39) and *U. signata* (quite many ♂♂, 1 collected, 1 photographed – Fig. 40a), and keeping to vegetation *Rhodothemis rufa* (several ♂♂ seen, 1 photographed – Fig. 41a, 1 ovipositing ♀ collected, 1 more ♀ photographed – Fig. 42a), *C. servilia* (several, 2 ♂♂ photographed sitting side-by-side - Fig. 36a), *B. chalybea* (1 ♂ photographed), *N. tullia* (several, 1 ♂ photographed – Fig. 43), *O. sabina* (several), while *B. contaminata* (many) kept to the water, *A. panorpoides* (1 ♂ seen) to water hyacinth and *D. trivialis* (1 ♂) to the ground. A short stop in the late low season (not taken into account in Table 1) on 15.06.2018 revealed only quite many *B. contaminata* and a male of *I. decoratus*.

Figure 36. Males (a-b) and a female (c) of Crocothemis servilia**: c - near the Lake Tonle Sap bank 1 km S from the margin of Kampong Pluk village (Loc. KP1) 15.06.2018.**

KP3. (20 species) The flatland NNE of Kampong Pluk. Similar places separated from each other for 3 km were studied in the late low level season in February 2017 and in the high level season in November 2018, since in the second case the former place was inundated and no boat was available in that area. In June 2018 the elevated road to the village was being reconstructed that made the area inconvenient for study.

The area studied in the high level season on 2.11.2018 (1:50-3:10 p.m.) was in the coordinate range of 13.273-275 N, 103.987-992 E and 8.7 km NE from the lake bank. There was a low embankment separating two big areas quite deeply inundated by the lake water, a rice field on its SSW side (loocking as a vast open water surface with nothing emerging) and scrub on its NNE side. Evidently the embankment had not long ago appeared from water and was not yet completely dry; a trace on a pole evidenced that the maximum water level was some 1.5 m above it. The water between bushes of scrub was almost completely covered with water hyacinth and also some patches of thin Poaceae grass (Fig. 44). The scrub abounded in pond herons (*Ardeola speciosa* Horsfield, 1821 or *A. bacchus* (Bonaparte, 1855)). I examined few places where it was possible to descend from the embankment to the water and at one of them, among water hyacinth I found several *A. minima* and two bright red males of *C. praetermissum* (collected). Net sweeping on the scarce grass at the embankment sides provided a male of *I. senegalensis* and numerous *D. nebulosa*,

Figure 37. A male of Microgomphus phalantus jayavarman **in its type locality, at the margin of open and low seasonably flooded forest margin Lake Tonle Sap bank 1 km SSW of the margin of Kampong Pluk village (Loc. KP1) 15.06.2018.**

Figure 38. Pools in open tree stand at the western margin of Kampong Pluk village near the pagoda (Loc. KP2) in the early low water season (24.02.2017).

which was the most frequent dragonfly. Other dragonflies were also abundant and diverse: there were also numerous (mostly males) *C. servilia*, *T. pallidinervis*, *O. sabina* and *N. tullia* and fewer but still many *B. contaminata*, quite a few *R. variegata* and *R. phyllis*

Figure 39. A male of Ictinogomphus decoratus melaenops **eating** Rhyothemis phyllis **at the western margin of Kampong Pluk village near the pagoda (Loc. KP2), 24.02.2017.**

Figure 40. Males of Urothemis signata**: a - at the western margin of Kampong Pluk village (Loc. KP2), 24.02.2017**; **b - 3 km NE of the Phnom Krom hill (Loc. PK1), 26.02.2017.**

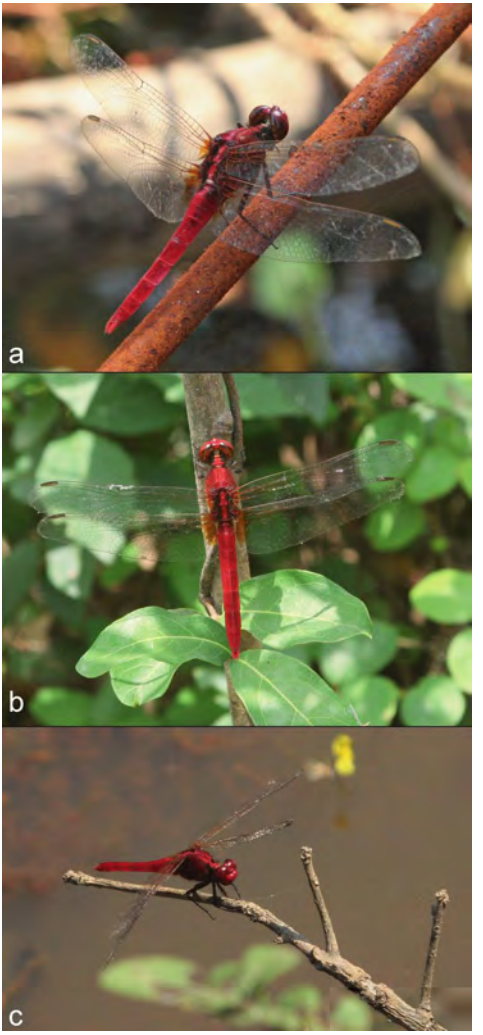


Figure 41. Males of Rhodothemis rufa**: a - at the western margin of Kampong Pluk village (Loc. KP2), 24.02.2017**; **b - 3 km NE of the Phnom Krom hill (Loc. PK1), 18.06.2018**; **c – at a scrub margin 10.7 km SSE of Siem Reap (Loc. WF3), 01.03.2017.**

in the air and *A. panorpoides* on water hyacinth. Infrequent were *T. tillarga* (2 already active ♂♂ seen), *Brachydiplax sobrina* (1 ♀ photographed – Fig. 45), *B. chalybea* (1 ♂ seen), *P. flavescens* (one soaring) and *R. rufa* (1 ♀ seen).

The area studied in the early low level season on 24.02.2017 was in the coordinate range of 13.251-253 N, 103.985-988 E and 6 km NNE from the closest lake bank. This was at the opposite, southern side of the above mentioned big rice field, just southerly of its margin and the beginning of the scrub area which extends to the lake not interrupted by any more fields. And it was a fairly weird terrain looking gloomy and absolutely dead, unlike anything I have seen on the earth (Fig. 46). The ground was almost barren, with very scarce grass and some rosette annual plants; sparse and dead-looking bushes and low trees stood above it. They were completely dry and thickly covered with thick carpets of dry ivy woodrose which incorporated quite a lot of dead water hyacinth and sheets of dead thread algae. (Actually on the same day immediately at Kampong Pluk (KK1) I saw the same vegetation but green and full of life, with the ivy woodrose blooming.) There were scarce very shallow and muddy pools with yellow water and several flowering groups of water hyacinth. There were scarce *I. senegalensis*, *A. pygmaea* and *B. contaminata*. Near the embankment, a deep ditch went across the terrain with slightly turbid running water, most probably pumped from somewhere upstreams. There were numerous *B. contaminata*, quite many *I. senegalensis* (including tandems, photographed), few *A. pygmaea* and not less than 3 ♂♂ (1 collected) and 1 ♀ (collected) of *P. rubriceps*. On a very short but partly green grass nearby, *D. trivialis* were frequent (mostly immature, greenish, but mature

Figure 42. Females of Rhodothemis rufa**: a - at the western margin of Kampong Pluk village (Loc. KP2), 24.02.2017**; **b - 3 km NE of the Phnom Krom hill (Loc. PK1), 18.06.2018.**

Figure 43. A male of Neurothemis tullia **at a small pool at the western margin of Kampong Pluk village near the pagoda (Loc. KP2), 24.02. 2017.**

Figure 44. Inundated scrub with water hyacinth behind an embankment 8.7 km NE of Kampong Pluk village (Loc. KP3) at the high water season, 02.11.2018.

bluish males also occurred) and several *Ischnura aurora* were rather unexpectedly found (3 ♂♂, 1 ♀ collected 1 ♂ photographed – Fig. 47). The latter were so tiny and had curious shaking flight that were overlooked by me and discovered only by my 6 years old son Valentin (Fig. 46 below). There were also a shallow ditch along the high embankment of the main road, with a tiny stream seeping over red mud. There were again numerous *B. contaminata* and quite many *O. sabina*, while net sweeping over low fine grass provided many *Argyocnemis*, of which I collected 4 ♂♂ and 2 ♀♀ of *A. pygmaea* and 2 ♂♂ 1 ♀ of *A. minima*.

Road to the watermelon field (WF)

I studied the area on the way from the eastern Siem Reap suburbs at ca 13.31 N, 103.90 E to WSW, towards an illegal watermelon field near the lake very bank at 13.22 N, 103.89 E, which is completely inundated at the high lake level. Most of this road serves as the border of Chreav District (Sangkat) of Siem Reap Municipality

Figure 45. A female of Brachydiplax sobrina **at inundated scrub 8.7 km NE of Kampong Pluk village (Loc. KP3), 02.11. 2018.**

(Krong Siem Reap) to the west and Prasat Bakong District of Siem Reap Province to the east, but close to the lake bank it enters the Sangkat Chreav territory.

Several parallel elevated roads go from populated area to the south through an 1 km broad belt of seasonably flooded scrub and join a perpendicular high latitudinal embankment at right angles at ca 13.29 N, with a road between two rows of tall eucalypts, which serves as a dam holding water in the scrub northerly of it to feed vast rice fields to the south. A lake-bound road at ca 109.90 E crosses the embankment, passes 2 km through the rice field and enters a next scrub zone, again 1 km wide, then for some 800 m follows a next contiguous stripe of rice fields and then alternating patches of inundated forest, bushes and rice fields. Before the end of the road, at the last rice fields, in the low season there is a very small temporary fishing village, then a stripe of seasonably flooded tall bushes/low trees 1 km wide, inside which, very close to the Lake Tonle Sap bank, there is a cleared area of an illegal watermelon field some 700 m long (13.224-229 N, 103.885- 890 E), which served as a landmark. At the high level season all this area is inundated, most probably except for the high eucalypt road.

In sum 30 species registered.

WF1. (9 species) The Tonle-Sap bank (13.2217-2227 N, 103.8870 E; 15.7 km SSE from the Siem Reap Centre; Sangkat Chreav territory. Accessible in the late low level season, studied on 13.06.2018 at 1:10-2:30 p.m. At the moment of examination, the water edge reached last trees (with dead bivalve colonies on branches up to 3 m above the ground!), then there was a very broad (ca 100 m wide) stripe of bulrush (*A. grossus*) emerging from water, which at its lake-facing margin reached the depth just above knee. The bulrush was sparse at the bank but became thick as the water deepened

Figure 46. Dry scrub 6 km NE of Kampong Pluk village (Loc. KP3) at the eraly low water season, 24.02. 2017.

(Fig. 48). The bottom was slightly sticky, the water was slightly turbid, reddish; almost hot in its shallowest parts and becoming moderately warm to the inner margin of the bulrush stripe where it got a smell of animal rot (dead snails?); open surface clean and wavy. There were an immense number of both sexes of *B. contaminata* (1 ♂ photographed), a school of which followed me in their accompanying behaviour. Closer to the bushes *C. servilia* were frequent (yellow individuals being more frequent than red males) and I repeatedly startled *I. decoratus*. Other odonates were very scarce. Two males (collected, 1 photographed – Fig. 49a) of *P. microcephalum* were found above the shallowest water, and one individual of each *R. phyllis* and *R. variegata* fluttered over this zone. In thick bulrush I found only a male of *P. rubriceps*, a copula of *I. senegalensis* (photographed) and a male of *B. chaybea*. No *O. sabina*! It seems that the shallow water of the bulrush zone was very low of oxygen so that even the commonest lotic species were depleted, but this obviously did not concern *B. contaminata*.

WF2. (16 species) From the temporary fishing village to the watermelon field, 13.226-247 N, 103.889-892 E; 13-15 km SSE from the Siem Reap Centre, 0.2-2.7 km from the lake bank; Sangkat Chreav District territory. Not acces-

Figure 47. Males of Ischnura aurora**: a - at a ditch in dry scrub 6 km NE of Kampong Pluk village (Loc. KP3) 24.02.2017**; **b - at the Mekong right bank in the Phnom Penh Centre (Loc. PP), 28.02.2017.**

Figure 48. The Lake Tonle Sap N bank 15.7 km SSE of Siem Reap (Loc. WF1) at the lake low water season (13.06.2018), with a broad bulrush (Actinoscirpus grossus**) stripe in water and low seasonably flooded forest on the bank (seen from distance on the lower photo).**

sible in the high water season; examined on 01.03. 2017 (Fig. 50), 13.06.2018 (Fig. 51) and 12.12.2019 (Fig. 52).

The lake bank is separated from the fishing village by thickets of tall bushes and low trees (of course all braided by ivy woodrose), through which a very bad tractor ground road goes for 700 m (13.226-233 N, 103.889-190) to the watermelon field; it was always badly trampled by buffalos and in December very muddy (Fig. 52 below). I shortly examined it on all the three above mentioned dates and in two cases found no dragonflies. On 01.03.2017 (1:50-2:30 a.m.; early

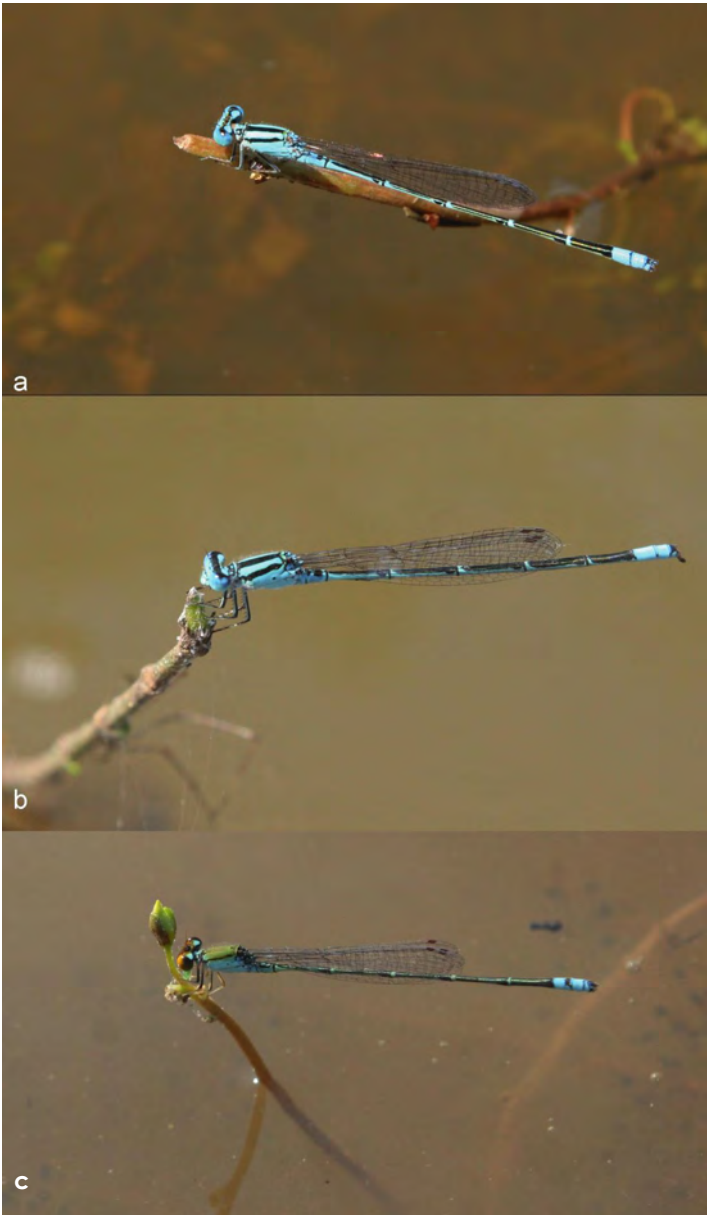


Figure 49. Males of Pseudagrion **spp. perching at open water: a – P. microcephalum among shallowly inundated bulrush at the Lake Tonle Sap N bank 15.7 km SSE of Siem Reap (Loc. WF1) 13.06.2018; b –** P. australasiae **in inundated scrub 9 km SE of Siem Reap (Loc. WF4), 05.11.2018; c –** P. rubriceps **in shallowly inundated scrub 4.5 km NNW of the Phnom Krom hill (Loc, PK2), 05.11.2018.**

low season) I was surprised to encounter there nine individuals of *Aethriamanta* sp. perching on tips of thin dry branches at the height of 2-3 m above the ground. Of them I managed to collect 7, 6 of which appeared to be females, 3 of *A. aethra* and

Figure 50. Swamps and rice fields divided by an embankment with a temporary fishermen tent village 13-15 km SSE of Siem Reap (Loc. WF2) at the early low water season (01.03.2017).

2 of *A. brevipennis*, the remaining one was a young male of *A. aethra*. No doubt they bred from the nearby deep and hardly accessible swamps covered with water hyacinth, where mature males (which I did not see) should have awaited the females feeding at the margins of the surrounding thickets which I by chance found concentrated at that road.

The temporary fishing village (13.233-246 N 103.890-892 E) was composed of canopies on poles at both sides of the embankment with a 01.5 km long road from NNE to SSW, not better than described above, to the west of which there was a big rice field (Figs 50, 52) and to the east quite deep swamps full of water hyacinth and with sparse quite tall trees (Figs 50-52). On 01.03.2018 the rice was young and green (Fig. 50), on 13.06.2018 the fields were dry and on 12.12.2019 still partly inundated (Fig. 52). On 01.03.2018 the swamps were still waist deep (Fig. 50) and *Pistia stratiotes* and *Salvinia cucullata* Roxb. ex Bory were seen in water hyacinth. On 13.06.2018 the swamps were shallow and some areas were dried to deep mud covered with a thick carpet of water hyacinth (Fig. 10 below); the water became yellowish and some microscopic algae developed on the surface (Fig. 51); *Salvinia* became more abundant while *Pistia* was not noticed, and big patches of bulrush appeared. On 12.12.2019 the swamps were deeply inundated (Fig. 52) so that many boats were parked at the village. *B. contaminata* was invariably very numerous at

Figure 51. Deep roadside pools with water hyacinth at Loc. WF2 at the late low water season (13.06.2018).

the embankment and swamp margins at any season and at any visit; *C. servilia* was numerous and *O. sabina* frequent on 01.03.2018 and 12.12.2019 but on 13.06,2018 (late low season) only one male of each was met. On 01.03.2018, several *D. trivialis* (including mature males) and males of *U. signata* were seen and on 12.12.2019 many *T. pallidinervis* and one *R. variegata*. On 01.02.2018 many *A. pygmaea* (4 ♂♂ checked in hand) and 1 male of *I. senegalensis* were found at the inundated, fresh green rice field.

At the far (lake-side) end of the embankment there were deep roadside pools filled with water hyacinth and scarcely accessible because of the quite steep embankment and thorny bushes of *M. pigra* (Fig. 51). On 12.12.2019 they were still merged to the inundated larger swamps. On 01.03.2018 I found there only a male of *A. panorpoides*. On 13.06.2018 there were remarkably many *Ceriagrion auranticum* (2 ♂♂ collected) and *C. praetermissum* (4 ♂♂ 1 ♀ collected), among which I managed to find a male and an immature (red) female of *A. minima*.

WF3. (13 species) The elevated ground road with accompanying ditches, a small pool and a narrow rice field inside the broad stripe of seasonably flooded scrub (Fig. 53) dammed by the embankment parallel to the lake bank and closest to it. (On 12.12.2019, when the lake was shrunken, I saw how this worked: the water flowed through a pipe in the embankment from the scrub towards the lake, feeding the rice field). 13.2697-2712 N, 103.8977-8984 E, 10.7 km SSE from the Siem Reap centre, 5.2 km NNE from the lake

Figure 52. The same place as in Fig. 49 (Loc. WF2) but at the intermediate water season (12.12.2019).

bank (Sangkat Chreav/Sangkat Prasat Bakong border). Not accessible in the high level season; examined on the same days as WF2. On 01.03.2017 there were quite many *B. contaminata*, many *C. servilia* (mostly females, from yellow young to brown mature ones; 1 ♂ photographed), frequent *R. phyllis* and *variegata*, several *D. trivialis* (on the road), a male (photographed – Fig. 41c), two females of *R. rufa* and one *P. flavescens*. One of the roadside ditches contained quite a deep water without aquatic vegetation but with patches of dense fine semi-inundated grass, the net sweeping of which provided many males of *A. pygmaea* (5 checked in hand), 2 males of *I. senegalensis* and a female of *D. nebulosa*. The opposite ditch had shallow dark pools with flowering *Utricularia* sp., upon which a male of *I. decoratus* perched on a dry bush branch.

On 13.06.2018 (late low season) many *B. contaminata*, few *D. trivialis* and even a male of *I. decoratus* were again observed, but no other dragonflies. Only very shallow pools left in the deeper ditch (Fig. 53, above), over which there was a lonely male of a blue *Pseudagrion* (*P. australasiae* or *P. microcephalum*), which I failed to catch because it was attacked by a male *B. contaminata* (who missed it as well).

On 12.12.2019 I was surprised to find only one male of usually abundant *B. contaminata* but quite many *O. sabina* and *T. pallidinervis*, several (red and yellow) *C. servilia*, and one immature *D. trivialis*.

WF4. (19 species) The most inland broad stripe of seasonably flooded scrub (Fig. 54) dammed by the elevated road with eucalypts which serves as a reservoir for the vast rice field behind the dam, as well as for fishing. At the northern side there is some

Figure 53. A narrow rice field in seasonably flooded scrub 10.7 km SSE of Siem Reap (Loc. WF3): above - at the late low water season (13.06.2018); below – at the intermediate season (12.12.2019).

deeper water reservoir (ca 230 x 200 m) with open water, also used for fishing. At the high level season the water at the embankment (ca 13.291 N) was more than a waist deep, gradually became shallower to the north to disappear at ca 13.30 N. At the late dry season only very shallow pool remained along the dam, which, however, deserved a study. Unfortunately, the area was studied (ca 450 x 300 m; 13.291--295 N, 103.909-911; 9 km SE of the Siem Reap centre) only at the high level season on 05.11.2019 (9:30-11 a.m.) and the late intermediate season (shortly in the evening of 02.12.2019 and at 12 a.m. – 13:15 p.m. on 12.12.2019). Most thoroughly studied was the area of some 150 x 150 m (13.294-295 N, 103,909-910 E) where the water was conveniently about knee-deep and the bushes (including *M. pigra*) were sparser. A remarkable feature of the place was the abundance of flowering floating plants, lilac *Rotala* sp., yellow bladdenwort (*Utricularia* sp., like *U. aurea* Lour. but with curiously thick floats – Fig. 55), white water lily (*Nymphaea* sp.) and water snowflake (*Nymphoides indica* (L.) Kuntze), the latter being especially abundant in December (Fig. 54, except for the top photo). Curiously, there was no water hyacinth there.

Figure 54. Inundated scrub 9 km SE of Siem Reap (Loc. WF4), a habitat of diverse odonate assembly; top photo – at the high water season (05.11.2018); other photos – at the intermediate season (12.12. 2019). The white spots in the lowest and second top photos are the water snowflake (Nymphoides indica**), those in the second low photo are egrets.**

There was also sparse and thin emerging grass, to which in November quite a few damselflies were confined: *Aciagrion borneense* (many ♂♂, seemingly aggregated; 4 collected, some photographed – Fig. 56), *I. senegalensis* (few ♂♂ and ♀♀; 1 ♀ collected), *P. australasiae* (few very actively flying ♂♂, 2 collected, 1 photographed – Fig. 49b), *P. calamorum* (few ♂♂, conspicuous whitish on the broad leaves of *Nymphaea* and *Nymphoides* which they occupied; 2 ♂♂ photographed – Fig. 57b), *A. minima* (1 ♀ photographed), *P. rubriceps* (1 ♂ at a deeper place). In December the environment looked similar (but a mass flowering of water snowflake) but the damselflies were almost absent: for more than an hour I found only a male, a female (collected) and copula of *I. senegalensis* (Fig. 55) and, at the smaller water reservoir, a male of *A. pygmaea* (collected).

The dragonflies were diverse in November: *O. sabina* (very many everywhere), *C. servilia* (many, both sexes), *T. tillarga* (many active between bushes in the morning), *T. pallidinervis* (many ♂♂ on sticks; 1 photographed), *B. contaminata* (few ♂♂), *P. flavescens* (few soaring), *R. phyllis* (few soaring), *D. trivialis* (few on the road), *D. nebulosa* (few, mostly males, in emerging grass), *Neurothemis fulvia* (a male on a bush), *Hydrobasileus croceus* (a male flew twice across the same gap between bushes

Figure 55. Copula of Ischnura senegalensis **on a bladdenworth (**Utricularia **cf.** aurea**, but with unusually inflated floats) in inundated scrub 9 km SE of Siem Reap (Loc. WF4), 12.12.2019.**

and disappeared). In December 2019 dragonflies also appeared less diverse than in November 2018: very many *B. contaminata*, many *O. servilia*, *T. pallidinervis*, few *D. trivialis*, *D. nebulosa*, *O. sabina*, *P. flavescens*, solitary *P. congener* (a young male) and *T. tillarga*. At this time, males of both *P. flavescens* and *D. trivialis* were reproductively active, that is not too often observed for these widespread species. The former coursed over the water and even chased each other; the latter (all blue) perched on emerging stems (but did not keep to the same perch), were cautious and flew fast and far when startled. That was so dissimilar to the 'normal' and habitual behaviour of non-breeding males which rest on barren ground, are not cautious and fly for very short distance.

Swamp between Phnom Krom and Sambuor villages (PK)

In 9.9 km to SW of the Siem Reap City centre there is a sharp rocky hill called Phnom Krom (Figs 58-59) (Khmer: Lower Mountain; 13.28-29 N, 103.81-82 E) with Prasat Phnom Krom Temple, built at the end of 9th century, on its top. The hill foot is narrowly surrounded by Phnom Krom village and further with vast rice fields (Fig. 58-59). These are completely inundated during the high level season (Figs 58, 59, bottom photo), while in the low level season the water front is 5 km to the south. In 700 m north of the hill foot (13.2940 N, 103.8140 E), a high embankment, with an elevated ground road upon, starts and goes to the west and then to north-west. The state of the road in November suggested it had been inundated at the highest lake level. The embankment serves as a dam of a 3 x 2 km water reservoir aimed to feed the rice fields at its S/SW side. It is much deeper than other reservoirs along the northern lake bank, being a huge

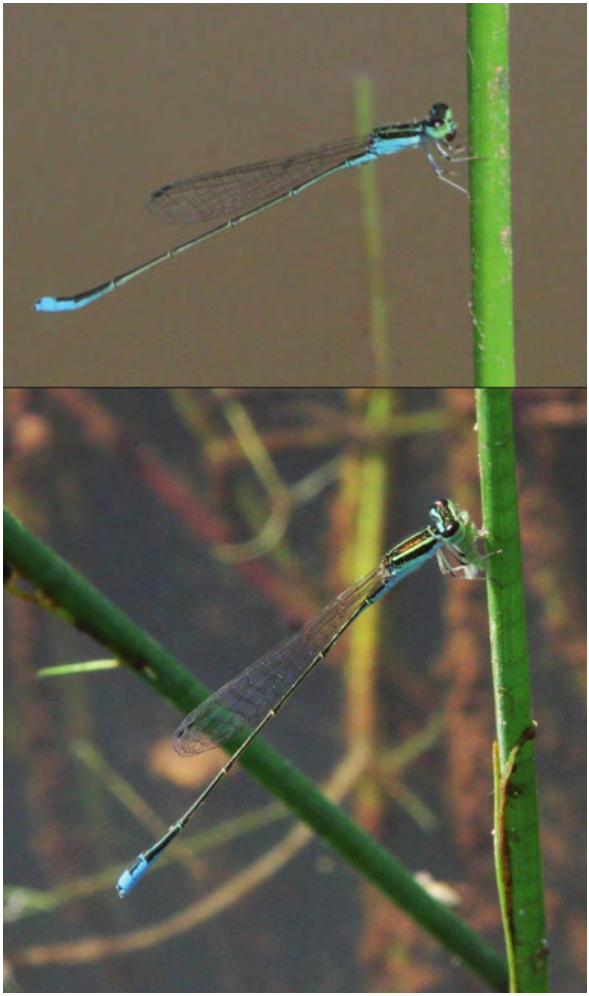


Figure 56. Males of Aciagrion borneense **in sparse emerging grass in inundated scrub 9 km SE of Siem Reap (Loc. WF4), 05.11.2018. The photographed male(s) and one collected male of** A. borneense **had S9 entirely blue, as usual for the species, but three collected males had a narrow black dorsal streak throughout it. Laidlaw (1924) admitted possibility of dorsal black marking on S9 in males this species.**

swamp thickly overgrown with floating vegetation which from distance would look as a meadow if people would not move across it by boats (Fig. 60, the second photo from bottom). In 4 km NW from Phnom Krom (13.3128 N, 103.7905 E), the embankment forks and the right branch goes through the swamp western margin northwards to Sambuor village (13.33 N, 103.80 E). The swamp attracts Openbill Storks and other birds and is full of all kinds of wildlife. The depth and other conditions of this swamp do not change during the season as much as in other areas near the lake. At the late low season, bulrush (*A. grossus*) patches (but not too large) appear at the 'rice side' of the embankment. The swamp margin along the embankment was studied on 26.02.2017 (11:30 a.m. - 1:20 p.m. and 4 - 6 p.m.) and 01.03.2017 (5 - 6 p.m.) in early low season, 18.06.2018 (11 a.m. – 1 p.m.) in late low season, 03.11.2018 (5:10 - 6 p.m.) and 05.11.2018 (12:40 a.m. – 1:30 p.m.) in high season, and 12.12.2019 (4 – 5:20 p.m.) in late intermediate season. In sum 24 species registered.

PK1. (20 species) The deep swamp part from the start of the embankment to its fork: 13.294-313 N, 103.791-814 E (with the preferred section 13.302-306 N, 103.791-794 E; 2.8- 3.4 km NE of Phnom Krom). The SE corner of the swamp closest to Phnom Krom is more than a hu-

Figure 57. Males of Paracercion calamorum **perching at open water: a – in shallowly inundated scrub 4.5 km NNW of the Phnom Krom hill (Loc, PK2), 26.12.2017**; **b – in inundated scrub 9 km SE of Siem Reap (Loc. WF4), 5.11.2018.**

man height deep, has some areas of open water alternating with water hyacinth carpets (Figs 10 (two top photos), 60). Further to northwest the water becomes about waist-deep and filled with some semiaquatic Poaceae grass with very thin leaves, abundant *Salvinia cucullata* and some *Nymphoides indica* and *Ottelia* sp., while the higher level is dominated with tall lotus (*Nelumbo nucifera* Gaertn.) (Figs 61-63). The grass (well seen in the lower photo of Fig. 63) forms a floating bog, upon which it was possible to move by 'crawling' but by neither walking nor swimming. Sparse low trees and bushes (partly dead), as usual covered by ivy woodrose, rise from the water (Fig. 63). There are lines of 'normal' trees and bushes aside the embankment road where many larger dragonfly concentrate.

In accordance with less profound seasonal changes of this habitat, the odonate assemblage did not change much as well, as I do not think the below reported fluctuations reflect some regular seasonal cycles. Large dragonflies, concentrated at the embankment, were represented by *C. servilia* (quite many in February (1 ♂ photographed) and, mostly females, in June, very many in November and December), *T. pallidinervis* (very many in February, not registered in June, quite many in November and December), *U. signata* (many in February (1 ♂ photographed – Fig. 40b), few

Figure 58. Phnom Krom Hill 9.9 km SW of Siem Reap in the high water season. The two top photos represent an unusually high lake level in November 2011. Photos by Eddie Smith.

in June, not registered in November, 1 ♂ seen in December), *O. sabina* (few in June, many in November, no in December). *R. rufa* (registered only in June, many males on the water invariably with lotus, females at embankment bushes, 1 ♂ (Fig. 41b), 1 ♀ (Fig. 42b) photographed), *R. phyllis et variegata* (as usual always on the wing; few in February, very many in June, 3 ♀♀ of *R. variegata* in November, not seen in December), *P. flavescens* (1 territorial ♂ in November, many in December), *T. tillarga* (few commenced a twilight flight in February). Of smaller dragonflies, *B. contaminata* was numerous and dominated among small dragonflies in all seasons, it kept to windows of open water and avoided thick lotus thickets. *A. panorpoides* and *D. nebulosa* (both photographed – Figs 64-65) occurred at lotus thickets and less readily at the water hyacinth matts: both were numerous in February, in June the former was frequent but the latter not seen, in November none of the former and many of the latter were seen, in December one individual of the former and quite a few of the latter were observed. In February few males and in November one male of *B. chalybea* occurred in the same floating vegetation habitats. A male of *D. trivialis* was met in February in grass at the embankment. Two males and a female of *N. tullia* were seen at bulrush in June and one male at water hyacinth in November. *A. aethra* was observed only in June: a male (Fig. 35c) and female (Fig. 35b) (photographed) close to each other on lower branches of a bush on the embankment and a male on a water hyacinth matt.

Of damselflies, *Agriocnemis* spp. were expectedly found on the water, especially in fine grass, but were few in February (*A. minima* and *A. pygmaea*, the latter represented by one female) and June (*A. minima*; 1 ♀ photographed), not seen in November but numerous in December (seemingly all *A. minima*; 4 ♂♂ collected). *I. senegalensis* was not too rare in December but otherwise only a male and female were seen in February. Such solitary findings were also made as a male of *C. cerinorubellum* (collect-

Figure 59. Phnom Krom Hill (middle) and rice fields nearby: top and middle – at the low water season (26.02.2017 and 22.02.2017, respectively); bottom – at the high water season (3.11.2018).

ed) in the grassy floating bog in February and a male of *P. australasiae* in November.

PK2. (16 species) The right arm of the embankment from its bifurcation for 1-1.5 km to the north (at this section with a line of young eucalypts): 13.313-321 N, 790-793 E, 4-4.8 km NNW of Phnom Krom. The water, now at both sides of the embankment becomes shallower (its level strongly changes during the season), with a silty but not sucking bottom. Aquatic vegetation became scarce and regular seasonably flooded scrub appears (Fig. 66). Macrophytes were represented by *Utricularia* sp. (a lot in February), *Nymhpaea* sp., *N. indica* and *Rotala* sp. (many in November, see bottom photos of Fig. 66); the water hyacinth occurred at deeper places at bushes. Examined on 26.02.2017 and 05.11.2018. Dragonflies: *O. sabina* (both times numerous); *C. servilia*, *D. nebulosa* (few in February, many in November), *B. contaminata*, *T. pallidinervis* (many in February, few in November), *R. variegata* (both times frequent), *U. signata*, *R. phyllis*, *P. flavescens* (frequent in February),

Figure 60. The water hyacinth carpet in a huge swamp 1-2 km NW of Phnom Krom Hill (Loc. PK1); the second photo from bottom of 12.12.2019, others of 1.11.2018.

D. trivialis (few in February on the solid ground).

Of damselflies, in February only quite frequent males (1 collected) of *P. calamorum* were observed, perching on solitary floating leaves of bladdenwort or water lily (Fig. 57a). In November they were rather fewer but there were also *A. borneense* (quite a few ♂♂ in sparse emerging grass), *I. senegalensis* (quite a few ♂♂, few ♀♀), *P. australasiae* (few ♂♂ and ♀♀; 1 ♂ and 1 ♀ collected), *P. rubriceps* (2 ♂♂, 1 photographed – Fig. 49c) and *A. minima* (1 ♀).

Merchey

To the west of Siem Reap, opposite to the SW corner of West Baray, a road branches off the National Highway No.6 to SW and goes to Merchey village which is connected by a canal to the lake and so serves as one of the two water gates leading to the Stung Sangkae River mouth, which numerous birdwatchers visit. We visited Merchey (13.358 N, 103.717 E) shortly on 01.11.2018 and found the land inundated, with big water spaces between bushes where water hyacinth matts floated. We examined a short section of some ground road which was just appearing from the water at the village but still inundated further to the west (Fig. 67). There were numerous *B. contaminata* and *D. nebulosa*, many *C. servilia* (all females; even immature yellow males were absent but I noticed some orange dragonfly of a relevant size), *N. tullia*, *D. trivialis*, *O. sabina*, and I saw a soaring *P.*

Figure 61. The floating bog dominated by lotus in a huge swamp 2-3 km NW of Phnom Krom Hill (Loc. PK1); the second photo from bottom of 18.06.2018, others of 26.02.2017.

flavescens, an active male of *T. tillarga* and (already from inside a car) a tiny yellowish damselfly (*?I. aurora*) flying by. Eight species.

Prek Toal (PT)

Prek Toal (Preaek Toal) is a Cham floating village (Kaoh Chiveang Commune, Aek Phnum District, Battambang Province) (Fig. 68) at the Stung Sangkae River near its mouth which the Osmose Community Project has made the first must see (and hence quite expensive) place for birdwatchers in Cambodia as a base of the Prek Toal Bird Sanctuary, a Ramsar Convention site. All published data on Odonata of Lake Tonle Sap (Benstead 2006; Roland & Roland 2010; Roland et al. 2011; Seehausen et al., 2016) originated from this place. I visited it only on 10.12.2019, arriving there by a big boat and examining the village closest surroundings (13.230-233 N, 103.665-670 E) using a small flat-bottomed boat from 1:30 to 2:30.

The river mouth (Figs 11, 69) was marked with thickets of the Giant Cane (*Arundo donax*), still inundated but with ca 1 m of stem length recently released from water and still having no leaves. They included some bushes of Giant Sensitive Tree (*Mimosa pigra*) and few tall trees. At the village, the river course was also marked

Figure 62. The floating bog dominated by lotus (Nelumbo nucifera**) and participation of** Nymphoides indica, Salvinia cucullata **and Poaceae gen. sp. in a swamp 2-3 km NW of Phnom Krom Hill (Loc. PK1), 05.11.2018.**

by lines of cane and bushes, behind which there were 'bays', of different size, of more open water among denser *A. donax* and *M. pigra* bushes. At the base of bushes and cane, water hyacinth was concentrated and the flowering morning glory (*Ipomea aquatica* L.) was frequent. The depth was mostly more than 2 m but in some places the bottom was reachable. Everywhere *B. contaminata* was present in immense numbers, males of *C. servilia* frequently occurred and one male of each *O. sabina, N. tullia,* and *D. nebulosa* were seen in the water hyacinth zone and a male of *U. signata* in the cane zone at the mouth. Quite surprisingly, there was not any *T. pallidinervis*. The most numerous damselfly, with frequent tandems, was *P. rubriceps* (3 ♂♂ 1 ♀ collected), less frequent were males of *P. microcephalum* (4 collected) and I. senegalensis (1 ♂, 1 orange ♀ collected). Interestingly, all these damselflies mostly occurred at the 'banks' (with water still more than 2 m deep) of the main river course, marked by cane and *M. pigra* bushes, but were scarce in 'bays'. At those 'banks', few males of *C. auranticum* (1 collected) were also met while in a 'bay' an immature, still red female of *Agriocnemis femina* was collected (the only one at the lake at all).

In total 11 species registered by me (but 22 together with the literature data).

Road from Mukh Paen to Sangkae River (MP)

During the high water season, Lake Tonle Sap increases its area partly in expense of the huge floodplain of the Stung Sangkae and smaller river entering it at its NW end.

Figure 63. Low trees in a lotus swamp 3 km NW of Phnom Krom Hill (Loc. PK1); the dates from top to bottom: 18.06.2018, 26.02.2017, 26.02.2017, 05.11.2018, 12.12. 2019.

It is some 50 km long and 35 km wide and is mostly covered by low seasonably flooded forest and scrub. The best way to examine that floodplain was to penetrate it via a 16 km long elevated road (well seen even from a plane, see Fig. 9) starting at the remarkable Big Tree (13.4720 N, 103.6088 E) at the S margin of Mukh Paen village (Mukh Paen Commune, Puok District, Siem Reap Province) and proceeding SW to a village on the Sangkae River banks (13.3481 N, 103.3279 E). The exact name of that village is unclear: in two different tourist maps it is indicated as Pou Treay or Chheu Kmau while is nameless in Google Earth. It is only clear that it is situated (like Prek Toal) in Kaoh Chiveang Commune, Aek Phnum District, already in Battambang Province. Since the sites examined resided in Siem Reap Province, I designate them 'MP' after Mukh Paen village.

This area was visited on 03.12.2019 and 13.12.2019 (both times from 10 a.m. to 2 p.m.), in the late mid-water season. Although the road still showed signs of very recent inundation (very bad but being repaired), the water had actually withdrawn from vast scrub of the floodland back to the river's very banks, having left a sticky wet ground. On the way from Mukh Paen village to the river, the road, as usual accompanied by a canal, crosses the following terrain: (i) overgrazed pastures, (ii) rice fields, (iii) dry wasting land with regenerating scrub (until this level the land seemed not be reachable by the lake high water), (iv) inundated scrub on the E side and rice field on the W side, (v) inundated forest composed by low trees braided with ivy

Figure 64. A male of Acisoma panorpoides **in a lotus swamp 3 km NW of Phnom Krom Hill (Loc. PK1), 26.02.2017.**

Figure 65. A male of Diplacodes nebulosa **in a lotus swamp 3 km NW of Phnom Krom Hill (Loc. PK1), 26.02.2017.**

woodrose (Fig. 70), (vi) large area of inundated grass (Fig. 71) (vii) non-inundated scrub at both sides, (viii) vast open areas with fine grass, solitary big trees and large shallow ponds (with a lot of water buffaloes and big flocks of open bill storks), currently with very wet sticky ground (Fig. 72), (ix) thick scrub with the same wet ground.

Figure 66. Inundated scrub at the NW corner of a huge swamp, 4.5 km NNW of Phnom Krom Hill (Loc. PK2); top photo of 26.02.2017, others of 05.11.2018. On the two lower photos numerous emerging Rotala **sp. with lilac inflorescences is seen.**

There was no possibility to study the river banks since they were completely occupied with the (very dirty) fishing village. There was a lot of water hyacinth along the bank but no other vegetation. Generally the river looked the same as at Prek Toal, differing only in having firm banks.

So I briefly studied three sites in zones (v), (vi) and (vii), considered below in the reverse order in line with the adopted principle 'from water to inland'. They were situated close to each other (within 1.7 km of the road, see Fig. 9) and differed as damselfly habitats while dragonflies were mostly the same, so I do not include them in Table 1 as separate entries. In sum, 19 Odonata species were registered.

MP1. The channel banks, scrub with wet ground and a considerable roundish reserve enclosed with low dams with trees; 13.396-398 N, 103.564-565 E. Examined at 12 a.m. -1:30 p.m. on 03.12.2019 and at ca 10:30 and 12 a.m. on 13.12.2019. Dragonflies were as follows: very numerous - *C. servilia* (but not too many mature red males) (Fig. 73, left); numerous - *O. sabina* (mostly at bushes), *B. contaminata* (at water); less numerous - *T. pallidinervis* (on sticks near the canal) (Fig. 73, right); frequent - *P. flavescens*

Figure 67. Inundated scrub and a road being released from water at Merchey village (Loc. M), 01.11. 2018.

Figure 68. Prek Toal floating village at the Sangkae River mouth (Loc. PT). 10.12.2019.

Figure 69. Inundated vegetation (mostly of alien species, Giant Cane and Giant Sensitive Tree) at the Sangkae River mouth (close to Loc. PT). 10.12.2019.

(soaring), *R. variegata* (fluttering), *D. trivialis* (at the canal); solitary – a male of *D. nebulosa*, a male of *N. fulvia* (both at the roundish reserve), a young male of *P. congener* (a male in scrub), *T. tillarga* (startled from bushes). On 03.12.2019 above a secondary road at the roundish reserve a mixed swarm was observed which included several *P. flavescens*, four *R. variegata* and one *R. phyllis*. No damselflies at this place.

MP2. A large, 700 x 400 m, knee-deep swamp filled with fine Poaceae grass (like at PK1) (Fig. 71), including a lot of *Salvinia cuniculata* and *Utricularia* sp. (but no lotus or water snowflake). Partly examined at 13.401-402 N, 103.566-567 E, at 12:10-13:20 a.m. on 13.12.2019. Of dragonflies, there were numerous *D. nebulosa* and frequent *O. sabina* while *B. contaminata* was represented by two males only. There was a male of *R. phyllis* which ranged to and fro above the water, that is patrolled a territory, unlike to fluttering in swarms so habitually observed for both sexes of this species and *R. variegata*. Damselflies were represented mostly by *I. senegalensis* while others were scarce: quite a few males and a tandem (collected) of *P. australasiae* at windows of open water (its males seem to tend to more actively and far flying over open water than those of other congeners), several females of *A. minima* (two collected) and one male of *A. borneense* (collected).

MP3. A waist-deep swamped margin of the inundated forest (Fig. 70) along the road; ca 13.406 N, 103.573 E (exact coordinates uncertain). Examined at ca. 1:40-2 p.m. on 3.12.2019. There were many

Figure 70. Inundated low forest on the Stung Kae/Tonle Sap floodplain ca 6 km SW of Mukh Paen village (Loc. MP3) at the intermediate water season, 13.12.2019.

Agriocnemis, of which 1 ♂ 3 ♀♀ of *A. minima* and 1 ♀ of *A. pygmaea* were collected, several *P. rubriceps* of both sexes, two females of *I. senegalensis* (1 orange ♀ collected) and a male of *P. australasiae* (collected). Also a male of *N. tullia* (without milky stripes on the wings, the condition of males developed in the dry season) was met.

Tonle Sap River in Phnom Penh (PP)

Although Phnom Penh is situated 116 km SSE off the Lake Tonle Sap SE end, it resides at the mouth/source (depending on the season) of the Tonle Sap River, the broadening of which the lake is, so it is reasonable to include here the Phnom Pehn observations made on 28.02.2017. In Phnom Penh, the river is enclosed to concrete so that natural vegetation is represented by only sparse and small patches of water hyacinth, and a lot of rubbish are everywhere at the banks. Just upstream the Royal Palace (11.568 N, 104.931 E) I found a small patch of a ground bank with some grass and small *Miscanthus* sp. thickets. There I saw very many *B. contaminata*, few *D. trivialis*, a male of *O. sabina* on the ground and a male of *T. pallidinervis* on a *Miscanthus* stem. This set was the same as would be met in similar conditions at the lake.

At the level of the Tonle Sap and Mekong junction, next to Himawari Hotel (11.559 N, 104.938 E), there is a patch of a gentle ground bank with green grass in which I found a male of *A. pygmaea* and two rare damselfly species: not less than three males of *I. aurora* and a male of *Amphiallagma parvum* (for my 13 visits to Cambodia I found this species only thrice).

In sum 7 species.

Figure 71. A big area of knee-deep inundated fine grass on the Stung Kae/Tonle Sap floodplain ca 8.5 km SW of Mukh Paen village (Loc. at the intermediate water season, 13.12.2019.

Figure 72. Open areas with sparse trees, being released from water, on the Stung Kae/Tonle Sap floodplain ca 15 km SW of Mukh Paen village at the intermediate water season, 13.12.2019.

Figure 73. A female of Crocothemis servilia **(left) and** Trithemis pallidinervis **(right) at the bank of the canal ca 7.5 km SW of Mukh Paen village (Loc. MP1), 03.12.2019.**

Curiously, that specimen of *A. parvum* (Fig. 74a) has its back side of the head blue entirely rather than with a blue butterfly-like shape as common for this species (Fig. 74b), otherwise fitting the species perfectly.

A note on Amphiallagma parvum

Beyond the above reported male, I collected this species in Cambodia twice: in Ban Lung, Ratanakiri Province (2 males) (Kosterin 2016) and at Choum Thom forest swamp in Prey Long Forest in Preah Vihear Province (also two males) (unpubl.). Those males had the occiput blue below and black above, with two narrow blue postocular spots on the black part, confluent to the blue of the low part and so forming a blue butterfly-like shape (Fig. 74b), more or less fitting the above descriptions by Fraser (1933). In contrast to them, the Phnom Penh male has the occiput entirely blue (Fig. 74a).

The latter condition corresponds to the original description of this species (by one male from India without further detail): "Face bleuâtre clair, y compris le devant des premiers articles des antennes, sans marques obscures distincte. Le dessus de la tête noir; taches postoculaires bleues, grandes, cunéiformes, immédiatement suivies en arrière par la couleur pâle, sans être délimitées de ce côté par du noir". [Light bluish face, including the front of the first antennae articles, without distinct obscure marks. The top of the head black; blue, large, cuneiform postocular spots, immediately

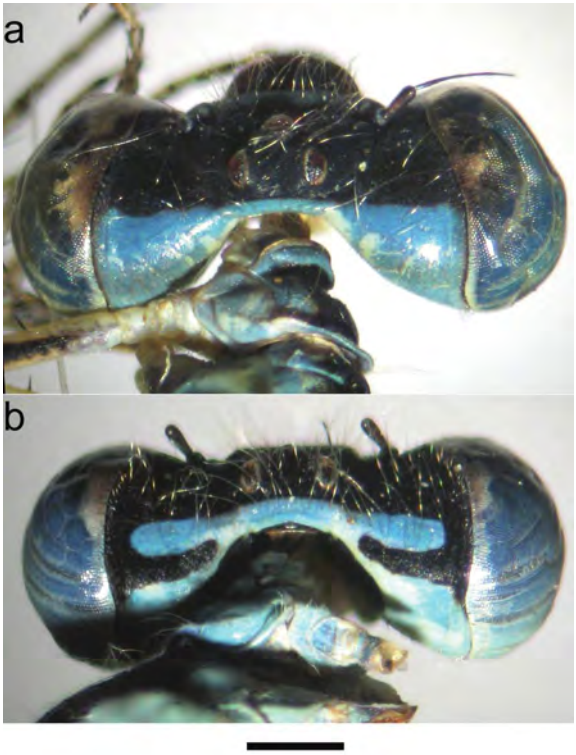


Figure 74. Heads of males of Amphiallagma parvum**: a – Phnom Penh centre, the Mekong River right bank at the ferry, 28.02.2017**; **b – Preah Vihear Province, 4.5 km WSW of Spong village, Lake Boeng Pes, 13.447-448 N, 105.505-506 E, 8.12.2019. Scale bar 0.5 mm.**

followed behind by the pale colour, without being delimited on this side by black] (Selys 1867: 536).

On the other hand, the description (from 'Sonder Bhandara, Central Provinces [of India]) of *Ischnura immsi* Laidlaw, 1913, a junior subjective synonym of *A. parvum* (Fraser 1933), reports the 'butterfly shape': "but the nasus black; upper surface velvety black, a linear postocular mark on either side, blue, meeting its fellow in the middle line" (Laidlaw 1913: 236). Note also the difference with Selys (1876) in the colour of anteclypeus. In contrast to Selys (1867), Fraser (1933: 376) also reported "postclypeus black or broadly black at base".

Fraser (1933) reported female dimorphism in *A. parvum* which also concerns the occiput coloration where it was not well explained: with the postocular spots either 'enclosed' or not. Less explicitly, he also hinted at existence of dimorphism in the occiput coloration in males, as follows: "vertex and occiput black, the latter with small postocular spots confluent across the middle line by a narrow occipital stripe" (Fraser 1933: 376), versus "In some specimens of the male the postocular spots are bordered narrowly with black behind, but the central stripe not so, so that the spots are narrow gulfs opening on to the blue at the back of the head" (Fraser 1933: 378). It is clear that although both statements were opposed by the expression "in some males", they describe the same 'butterfly shape', so it remains unclear what the alternative was implied, perhaps the entirely blue occiput. Moreover, it can be reconstructed that Fraser made lapsus calami and was going to say that in those 'some males' this alternative condition was found, since they were obviously implied to have a restricted black pattern: "In these specimens, also, the black on the postclypeus is restricted to its base, and the anterior collar of the prothorax is blue. The description of the type, writ-

ten, apparently, from a teneral specimen, approaches this condition, which is similar to that of the heterochromatic female, as the postclypeus is unmarked with black and the post ocular spots and stripes are unenclosed with black behind." (Fraser 1933: 378).

In iNaturalist.org there are 13 photographic observations of *A. parvum* showing the occiput. It has the 'butterfly-shape' in 10, in one the black 'enclosing' is very faint and in two the occiput is entirely blue. All the last three observations are from West Bengal, along with 7 others from there showing the 'butterfly shape'. Bedjanič et al. (2014) provided a photo of a male of *A. parvum*, from India with narrow black lines 'enclosing' the postocular spots to separate them from the blue below.

Few images and specimens available suggest that the 'butterfly shape' is common (14 cases), the entirely blue occiput is less frequent (3 cases) and the intermediate type with narrow black stripes is further less frequent (2 cases). This looks like an imperfect dimorphism or continuous variation. The black on the postclypeus is normal and its absence probably unusual.

Discussion

The registered fauna of Odonata at Lake Tonle Sap is rather scarce as counting just 41 species, so the above given ecological information, although difficult to generalise, makes more sense than the faunal data. To sum them up I provide in Table 1 a checklist of species with indication of localities where they were found by me, and in Prek Toal also by previous authors. Table 1 contains also subjective codes of abundance, relevance of which, as well of the species' presence as such, is limited by the fact that only three main localities, Kampong Pluk environs (PK), the road to the watermelon field (WF) and the swamp between Phnom Krom and Sambuor (PK) were examined on both high level season of the lake (November) and the low level season (February/March and June).

Only four odonate families are represented: Coenagrionidae (16 species), Gomphidae (3 species), Macromiidae (1 species) and Libellulidae (22 species, more than half). If not to consider Merchey and Phnom Penh, which were not studied properly, six species (all libellulids), *B. contaminata*, *C. servilia*, *O. sabina*, *R. phyllis*, *T. tillarga* and *T. pallidinervis*, were registered in all main localities and eleven species, *A. femina*, *A. nana*, *C. cerinorubellum*, *I. aurora*, *M. phalantus*, *S. clavatus* (not seen by me), *E. frontalis*, *A. brevipennis*, *O. sabina*, *H. croceus*, *P. jorina* were registered in one main locality only.

The species thriving and omnipresent at the lake banks themselves is *B. contaminata*, perhaps because of its ability to develop in both clear and turbid water and a habit to keep to open water and floating vegetation. Everywhere it was accompanied, but in much less numbers, by *O. sabina* and to some extent *C. servilia*. Two congeneric damselfly species feel at home on the floating vegetation (mostly water hyacinth) at the lake and Stung Sangkae River, *P. microcephalum* and *P. rubriceps*. Curiously *P. microcephalum* was confined to the lake itself and even at the end of the low season was found only at its bank (loc. WF1), while the very similar in appearance *P. australasiae* was never found at the lake itself but occurred over shallow water of inundated scrub further inland (WF4, PK1, PK2), where *P. microcephalum* was not in turn found. At least in Cambodia, these two species tend to exclude each other, however they can be found in the same habitats as well (Kosterin 2019b). A number of dragonfly species are very abundant at the lake banks near tall bushes of *M. pigra*, either inundated or not:

T. pallidinervis and *U. signata* (the former more frequent), which perch on protruding branches, and *R. phyllis* and *R. variegata* (most probably conspecific, see Kosterin 2010), which flutter among them. *T. tillarga* is abundant at the forest and scrub facing the lake, inundated or not, seemingly at any season. Other species at least once found at the immediate lake bank are *A. nana*, *C. praetermissum*, *I. senegalensis*, *M. phalantus*, *A. aethra*. The latter seemed out of place at a huge water body and probably arrived from some nearby smaller pool filled with water hyacinth. All the above mentioned species but *M. phalantus* and *A. aethra* are very common lentic species elsewhere in the Oriental ecoregion. For some reason I have never seen *P. flavescens* at the lake banks as such.

The rest of the revealed fauna is represented by widespread lentic species registered with various abundance (up to a single individuals, viz. *A. femina*, *A. nana*, *C. cerinorubellum*, *B. sobrina*, *H. croceus*) at various water bodies of the land periodically inundated by the lake water.

Interestingly, at the Stung Sanngkae River mouth at Prek Toal village, the overwhelming majority of damselflies occurred at the lines of water hyacinth at the base of the giant cane and giant sensitive tree marking the main river course, although still inundated by water more than 2 m deep, but were scarce in lateral 'bays' among these thickets, with seemingly the same conditions. This looked strange since the water of the main course was permanently disturbed by big motor boats (Fig. 68) so that the water hyacinth patches inhabited by these damselflies were repeatedly and severely shaken by waves, while the 'bays' were calm. I even suppose that it was this water shaking that attracted damselflies. For instance, according to my observations, the common northern Eurasian species *Erythromma najas* (Hansemann, 1823) is a predator specialised to hunt for small insects fallen to water: it perches on sparse floating plants among open water and makes shot flights towards sources of the surface oscillations. Those Cambodian damselflies which spend most of their life at floating water hyacinth may have the same trophic instincts. As a result, they eventually concentrate at those water hyacinth patches which undergo most shaking because of boats.

I would like to point out a useful cue for recognition in the field of very similar, saturated red mature males of *C. servilia* and *R. rufa* (females of which are so different). The former perch on top of stems and branches (Fig. 36a-b)while the latter invariably perch orienting their abdomen along a branch or stem (Figs 41) (besides, the colour of their abdomen looks a bit uneven). The conspicuous females of *R. rufa* often sit flat on leaves of bushes or low trees (Fig. 42a).

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Table 1. Checklist of Odonata of Lake Tonle Sap, with indication of localities and sublocalities were they were found by me (for the codes see the text), or previous authors which are encoded as follows: B – Benstead 2006; RR – Roland & Roland (2010); RSR – Roland et al. 2011; SCS – Seehausen et al. 2016. Codes for subjective relative abundance are given in parenthesis after (sub)localities 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). If a locality was visited in more than one season, a range of relative abundance is given, where 0 means a species was not observed on at least one seasonal examination (so one value provided most probably means that the locality was visited once rather than the species had stable abundance). Merchey is not included as examined too shortly.

	localities	KK		KP			WF				PK		PT	MP	PP
No	sublocalities species	KK1	KK2	KP1	KP2	KP3	WF1	WF2	WF3	WF4	PK 1	PK2			
1	*Aciagrion borneense* Ris, 1911	-	-	-	-	-	-	-	-	0-4	-	0-2	-	1	-
2	*Amphiallagma parvum* (Selys, 1876)	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	*Agriocnemis femina* (Brauer, 1868)	-	-	-	-	-	-	-	-	-	-	-	-1	-	-
4	*Agriocnemis minima* Selys, 1877	-	-	-	3	3	-	0-1	-	0-1	0-4	0-2	- RSR, SCS	3	-
5	*Agriocnemis nana* (Laidlaw, 1914)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
6	*Agriocnemis pygmaea* (Rambur, 1842)	-	-	-	3	0-3	-	0-3	0-2	0-1	0-2	-	- B	1	1
7	*Ceriagrion auranticum* Fraser, 1922	-	-	-	-	-	-	0-3	-	-	-	-	2 SCS	-	-
8	*Ceriagrion cerinorubellum* (Brauer, 1865)	-	-	-	-	-	-	-	-	-	0-1	-	-	-	-
9	*Ceriagrion praetermissum* Lieftinck, 1929	-	-	0-1	-	0-3	-	0-3	-	-	-	-	-	-	-
10	*Ischnura aurora* (Brauer, 1865)	-	-	-	-	0-2	-	-	-	-	-	-	-	-	2
11	*Ischnura senegalensis* (Rambur, 1842)	-	-	-	2	1-3	2	0-1	0-2	2	0-3	0-2	3 SCS	3	-
12	*Paracercion calamorum dyeri* (Fraser, 1919)	-	-	-	-	-	-	-	-	0-4	-	2-3	-	-	-
13	*Pseudagrion australasiae* Selys, 1876	-	-	-	-	-	-	-	-	0-2	-	2	-	2	-
14	*Pseudagrion microcephalum* (Rambur, 1842)	3	-	0-3	-	-	2	-	-	-	-	-	3	-	-

	localities	KK		KP			WF				PK		PT	MP	PP
No	sublocalities species	KK1	KK2	KP1	KP2	KP3	WF1	WF2	WF3	WF4	PK 1	PK2			
15	*Pseudagrion rubriceps* Selys, 1876	3	-	0-4	0-2	-	1	-	-	0-1	-	0-2	4 RSR	2	-
16	*Ictinogomphus decoratus melaenops* (Selys, 1858)	-	-	0-1	2	-	2	-	1	-	-	-	- RSR	-	-
17	*Macrogomphus phalantus jayavarman* Kosterin, 2019	-	-	0-3	-	-	-	-	-	-	-	-	-	-	-
18	*Sinictinogomphus clavatus* (Fabricius, 1775)	-	-	-	-	-	-	-	-	-	-	-	- SCS	-	-
19	*Epophthalmia frontalis* Selys, 1871	-	-	0-3	-	-	-	-	-	-	-	-	-	-	-
20	*Acisoma panorpoides* Rambur, 1842	-	-	-	1	0-3	-	0-1	-	-	0-4	-	- B, RSR	-	-
21	*Aethriamanta aethra* Ris, 1912	-	-	0-1	-	-	-	0-3	-	-	0-2	-	-	-	-
22	*Aethriamanta brevipennis* (Rambur, 1842)	-	-	-	-	-	-	0-2	-	-	-	-	-	-	-
23	*Brachydiplax chalybea* Brauer, 1868	-	-	-	1	0-1	1	1	-	-	0-2	-	-	-	-
24	*Brachydiplax sobrina* (Rambur, 1842)	-	-	-	-	0-1	-	-	-	-	-	-	-	-	-
25	*Brachythemis contaminata* (Fabricius, 1793)	3	4	4-5	4	3-4	5	5	1-4	2-4	4	2-3	4 RR, RSR, SCS	4	4
26	*Diplacodes nebulosa* (Fabricius, 1793)	-	-	-	-	0-4	-	-	0-1	2	0-4	2-3	2	3	-
27	*Diplacodes trivialis* (Rambur, 1842)	-	-	-	1	0-3	-	0-2	1-2	2	0-1	0-2	- RR	3	2
28	*Crocothemis servilia* (Drury, 1770)	-	3	2-3	3	0-4	3	1-4	0-3	3-4	3-4	2-3	3 SCS	4	-
29	*Hydrobasileus croceus* (Brauer, 1867)	-	-	-	-	-	-	-	-	0-1	-	-	-	-	-
30	*Neurothemis fulvia* (Drury, 1773)	-	-	-	-	-	-	-	-	0-1	-	-	-	1	-
31	*Neurothemis tullia* (Drury, 1773)	-	-	-	3	0-4	-	-	-	-	0-2	-	1 SCS	1	-
32	*Orthetrum sabina* (Drury, 1770)	3	-	2-4	2-3	2-4	-	1-3	0-3	2-4	0-3	3	1	4	1

	localities	KK		KP			WF				PK		PT	MP	PP
No	sublocalities species	KK1	KK2	KP1	KP2	KP3	WF1	WF2	WF3	WF4	PK 1	PK2			
33	*Pantala flavescens* (Fabricius, 1798)	-	1	-	2	0-1	-	-	0-1	2	0-3	0-3	- SCS	3	-
34	*Potamarcha congener* (Rambur, 1842)	-	-	-	-	-	-	-	-	0-1	-	-	-	1	-
35	*Pseudothemis jorina* Förster, 1904	-	-	2	-	-	-	-	-	-	-	-	-	-	-
36	*Rhyothemis phyllis* (Sulzer, 1776)	2	2-4	-	3	0-2	1	-	0-3	0-2	0-4	0-3	- SCS	2	-
37	*Rhyothemis variegata* (Linnaeus, 1763)	-	-	2-4	3	0-2	1	0-1	0-3	-	0-4	3	- SCS	4	-
38	*Rhodothemis rufa* (Rambur, 1842),	-	-	-	3	0-1	-	-	0-2	-	0-3	-	-	-	-
39	*Tholymis tillarga* (Fabricius, 1798)	3	-	4	-	0-2	-	-	-	1-4	0-2	-	- RSR	1	-
40	*Trithemis pallidinervis* (Kirby, 1889)	1	1	0-3	-	0-4	-	0-3	0-3	3-4	0-4	2-3	- RSR	4	1
41	*Urothemis signata* (Rambur, 1842)	1	1	0-1	3	-	-	0-2	-	-	0-3	0-3	1 SCS	-	-
	totally	11		28			30				24		22	19	7
		9	6	15	17	20	9	16	13	19	20	16			

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Odonata of Phnom Kulen Mts, Cambodia: a preliminary checklist

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Abstract

Phnom Kulen is a small and low plateau in the northern Cambodia still partly covered with evergreen forests and isolated from similar habitats by the Cambodian Lowland at least for 60 km. A preliminary checklist of its Odonata is provided, including 97 species. *Burmagomphus* sp. cf. *willamsoni* and *Macromia callisto* are for the first time reported for Cambodia.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Phnom Kulen Mountains, evergreen forest, androchromatic females in *Neurothemis fluctuans*

Introduction

Ponom Kulen are twin small (in sum ca 46 km long) and low (ca 200-487 m a.s.l.) bipartite plateaux which appear to be an island of evergreen rainforests amidst the Cambodian Lowland (Fig. 1), which is scarcely elevated above the sea level and almost totally converted to arable land. It was interesting to investigate the fauna of Odonata of Phom Kulen, both as providing promising habitats, including nearly pristine ones, and as an isolate from similar habitats elsewhere. The closest similar forests are found at the same low Dangrek Mountains some 60 km to the north. Of odonatologists, only Haruki Karube visited Phnom Kulen in 2000 but his data were not published. Here we provide a preliminary checklist of Odonata of Phnom Kulen based on data of different kind contributed by the authors: photographic data by Eddie Smith (E.S.) for 2012-2020 and focused odonatological research, including observing and some collecting, by Oleg Kosterin (O.K.) in 2017-2019. More studis were planned to complete the goal, but since the work in 2020 unexpectedly appeared impossible it worth publishing the existing data at least as a starting point for further research.

Methods

E.S. has been photographically recording Odonata of Phnom Kulen Mts, among other wildlife, since 2014, using cameras SONY DSLR-A100, SONY DSLR-A850, SONY

DSC-RX100M2 and before 2016 and SONY SLT-A99V since 2016. Being a microlight pilot he made preliminary scouting for promising habitats (streams and reservoirs) from the air. His photos are considered and identified by O.K. O.K. has visited Phnom Kulen specially for searching Odonata on 23.02.2017; 11-12.06.2018, 14.06.2018, 17.06.2018, 30.06.2018, 1.07.2018, 3-4.11.2018, 6.11.2018, 10-11.03.2019, 28-30.03.2019; 2.12.2019, 11.12.2019 (dates are provided in dd.mm.year format), 17 days in total. He registered common species by sight or photography and collected few specimens with a hand net when necessary; these are stored in the author's collecion and Naturalis Biodiversity Center, Leiden, the Netherlands. The photos of Odonata by E.S. were mostly presented in the Facebook group 'Natural Cambodia' and partly in iNaturalist.org (see the user @hondapcx), all photos by O.K. are presented in iNaturalist.org (see the user @oleg_kosterin); both photo sets are easy to find in iNaturalist under the project 'Odonata of Cambodia'. Coordinates, in the decimal degree format, were recorded by O.K. with Garmin eTrex H personal GPS navigator but their ranges for the areas actually examined were revised using Google Earth; E.S. recorded them automatically since 2016 by GPS navigator embedded in the camera SONY SLT-A99V. Since the data by O.K. and E.S. so differ in their nature and approach, in the annotated list below they are provided separately for each species, after the headers O.K. and E.S. For the data by O.K. their nature are indicated as follows: collected specimens - "collected"; natural photographs (taken with Canon EOS 350D camera with a Sigma AF 24-70 mm F2.8 EX DG MACRO lens) - "photo"; visual observations - "seen"; all data by E.S. are photographs by default. Before 2016, he used cameras without embedded GPS navigator and marked photos as taken generally in Phnom Kulen. Their more precise provenance cannot be traced, so they are provided under the header 'Not located'. All such photos were made in the eastern plateau. (However, some of E.S.'s photos for that period were located in his annotations in Facebook posts). The authorship of the photographs below is indicated as O.K. (Oleg Kosterin) and E.S. (Eddie Smith).

The area

The Phnom Kulen Mts are situated in the northern part of Siem Reap Province and are two twin pear-shaped sandstone plateaux extended from NW to SE and directed by their narrow ends towards each other, with a 1.5 km wide gap between them (Fig. 1), through which National Road 67 goes from Siem Reap to Anlong Veng. The NW plateau has the dimensions of 20×11 km, the SE plateau 28×15 km. They have nearly flat, moderately elevated (from ca 200 to 487 m a.s.l.) surfaces (Figs 2-3) but quite steep slopes (Fig. 4), however the NW plateau has a branchy, lower but rocky western spur. Since the plateaux get at least rare small rains even in the dry season, the natural vegetation of the top surface is evergreen rainforest (Fig. 5) and that of the slopes is sparse deciduous forest (Fig. 4). Both in general appearance and in biogeographical sense Phnom Kulen is a forest island among vast open landscapes – deforested farmland to the south and open low deciduous forests of *Dipterocarpus intricatus* Dyer to the north. (There is no surprise that Phnom Kulen served among the last Khmer Rouge strongholds.) The SE Plateau is drained by a considerable river known under the names O'Dar, Prey Thom, 1000 Linga River, Chup Preah and Siem Reap (these

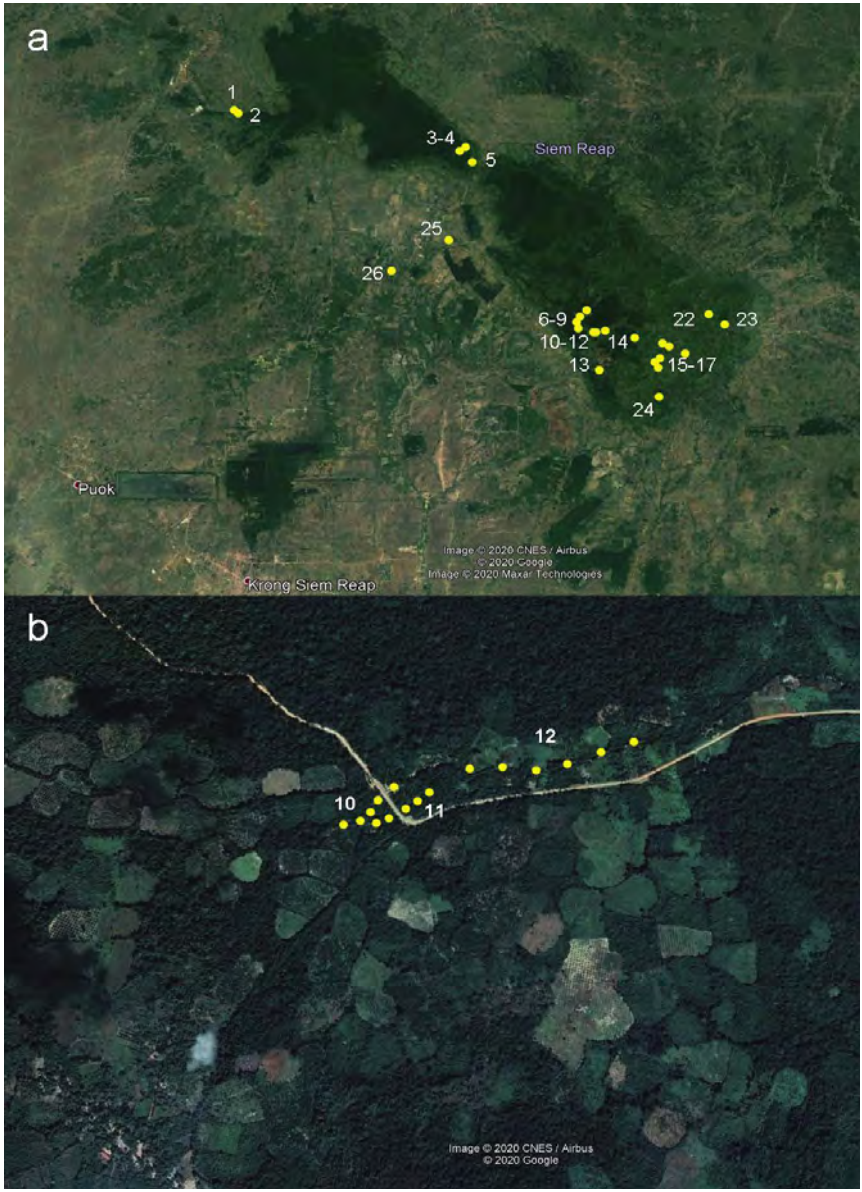

Figure 1. Disposition of localities studied (Loc. 1– Loc. 26), shown as dots, in the Phnom Kulen Mountains and of Loc. 10 – Loc. 12, shown as series of dots, in a larger scale image. Locality numerals are indicated, for explanation see the text. The images are adopted from Google Earth.

Figure 2. A view on the Phnom Kulen eastern plateau from the south, 25.09.2019. E.S.

Figure 3. A view on the Phnom Kulen eastern plateau from the east; see the new road being constructed. February 2019. E.S.

names more or less change from the sources towards downstream). For similicity further in the text this river will be mostly referred to as the Siem Reap River. It has a famous tall waterfall (Fig. 6) being a good dragonfly place. Both plateaux have many smaller rivers and brooks. In the SE part of the SE plateau there are some areas of flat sandstone outcrops with sparse savannah-like vegetation (Khmer 'veal'), the largest (1.7×1 km) situated to the east of Thmei village. There is a remarkable 'floating forest' at Tnal Mareh terrain, where a branchy stream flows through a swamped forest with trees producing numerous pointed pneumatophores, strongly resembling mangroves (Fig. 7). Such floating forest was said to exist also at Tmar Truonh village. A

Figure 4. Western foothills of the Phnom Kulen eastern plateau: 16.12.2019, E.S. (top), 10.03.2019, O.K. (middle), 11.06.2018, O.K. (bottom).

similar habitat was examined by O.K. in 2019 in Prey Long Forest in Stung Treng Province (Kosterin 2020a). However, it is unclear if these habitats are fully natural or formed in the bottoms of the former big water reservoirs after them being destroyed (at least a thousand years ago Tnal Mareh served as a clay quarry for a ceramic factory).

The SE plateau has been densely inhabited for not less than a thousand years and always was a sacred place. There in 802 Jayavarman II proclaimed the independent Khmer Empire (Kambujadesa) with the capital of Mahendraparvata (the same name being applied to the mountains). In later decades he left it in favour of the new capital Hariharalaya at Lake Tonle Sap. Later Phnom Kulen served a source of stone blocks for construction of the famous temples of the Angkorian complex, which were transport-

Figure 5. Evergreen forest on the upper part of the western slope of the Phnom Kulen eastern plateau, 11.06.2018, O.K.

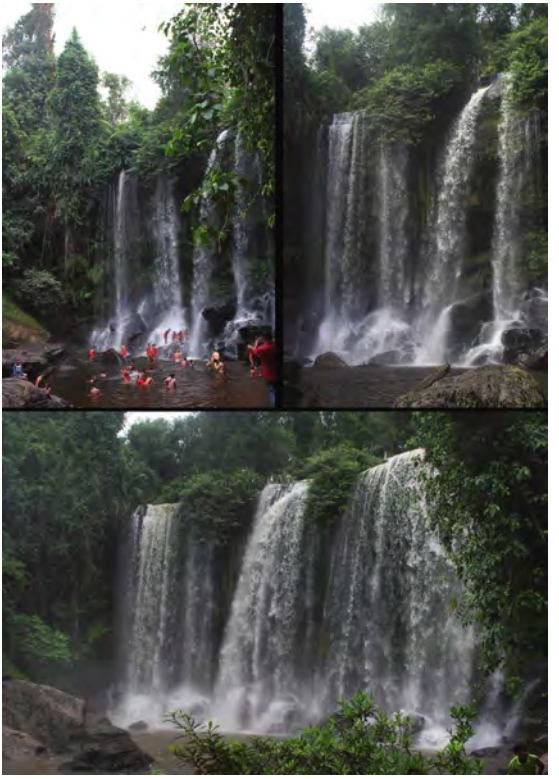

Figure 6. The Phnom Kulen Waterfall (Loc. 8) with varying amount of water: 23.02.2017 (top left), 12.06.2018 (top right) and 17.05.2018, O.K.

Figure 7. 'Floating forest' at Tnal Mareh terrain (Loc. 17). Numerous pneumatophores are seen in the left and right bottom photos. 28.11.2019, O.K. A habitat of A. viola, C. cerinorubellum, P. williamsoni, C. vittata, P. ciliata, B. oculata, Nannophya pygmaea, N. fluctuans **etc.**

ed from there to the Lake Tonle Sap vicinities via impressive artificial channels. Phnom Kulen harbours remarkable monuments of the pre-Angkorian period: thousands of lingas carved (to provide fertility downstream) in the bottom of the Siem Reap River (Fig. 8), the biggest in Cambodia Buddah statue called Preah Ang Thom, two ancient elephants carved from rocks, Damrei Krab (Fig. 9a) and Damrei Sras (Fig. 9b), and quite a number of pre-Angkorian temple ruins of different state of preservation. At the Rong Chen Archaeological Protected Area a ceramic factory was founded at the same time when the Empire was proclaimed and have been existing for half a century, so that the ground under the forest is presently full of broken ornamental ceramics (Fig. 10). There were not less than four big artificial water reservoirs (Khmer 'baray'): Ta Penh, Tnal Dach (the present name, 'broken dam' in Khmer), Srae Tbong and Tnal Mareh. However, the dams were destroyed by American bombing in the course of the so-called Operation Menu in 1969-1970 so that three of them have no more water and only the dam and reservoir of Tnal Dach (Fig. 11) was restored in 2012. The traditional land use on the SE Phnom Kulen plateau is 'circle agriculture' (a kind of slash-and-burn agriculture): the forest is cleared and burnt in a rounded territory some 150-200 m in diameter, crops are grown, then the circle is abandoned and re-used each 6-7 years. At present most of the plateau surface, as viewed from above (Fig. 1b), is a mosaic of adjacent cleared circles separated with narrow bor-

Figure 8. Numerous 'lingas' carved in the sandstone bottom of the main river of the eastern plateau of Phnom Kulen (the Siem Reap River) (Loc. 7): 23.02.2017, O.K. A habitat of V. gracilis, N. chinensis, Euphaea sp., B. contaminata, O. chrysis, O. glaucum, O. neglectum, O. sabina, T. aurora, T. festiva **etc.**

Figure 9. Elephants carved from sandstone rocks on the eastern Phnom Kulen Plateau, Damrei Krab (a) and Damrei Sras (b), 30.06.2018, O.K.

ders of remaining forest trees. In 2003, cashew was introduced and since 2008–2009 the cashew growing appeared the predominant land use. Only some areas of pristine forest are still protected, like Preah Thom (Khmer 'big forest') Community Protected Area (ca 5×3 km) at the Preah Ang Thom and the waterfall. Presently a good paved road is being constructed through the SE plateau (Fig. 3), said to serve for construction of a town of luxuriant villas, naturally for Chinese money.

Figure 10. Shards of the Kambujadesha time ceramics piled at Rong Chen Archaeological Protected Area, near Tnal Mareh terrain (Loc. 17), 28.11. 2019, O.K.

Figure 11. Tnal Dach Reservoir (Loc. 20) as viewed from the air, 15.06.2019, E.S.

Figure 12. Carvings in the sandstone bottom of the Kbal Spean River on the western Phnom Kulen Plateau (Loc. 4), 14.06.2018, O.K.

Figure 13. The river (Loc. 1) 12 km NNE of Phnom Peung Tanon Resort at the lowering western spur of the western Phnom Kulen Plateau, 25.12.2019, E.S. Habitat of I. senegalensis, P. australasiae, P. rubriceps, B. contaminata, C. servilia, O. luzonicum, O. sabina, T. aurora, T. festiva, T. pallidinervis **etc.**

For some reason the NW plateau remains unexplored and undisturbed, still being covered with vibrant pristine rainforest. However, the Kbal Spean (Khmer 'head bridge') River in its SE part is famous for the linga carvings in its bottom, even more impressive than those on the SE Plateau (Fig. 12). The lowering wester spur of this plateau has high rocks but is scarce in water.

Localities examined

The localities are numbered and given short nicknames (provided in the list in brackets), both are alternatively mentioned in the text below. Their disposition it shown in Fig. 1. Dates of examination by O.K. (if any) are provided; and of examination by E.S. for localities not examined by O.K. In the captions to photographs illustrating habitats, either the most common (but not obviously immigrated from elsewhere) or most interesting dragonfly and damselfly species occurring therein are mentioned.

Western plateau

Loc. 1 (Peung Tanon River): a small river 900 m downstream (NW) of its leaving the low and rocky W spur of the western plateau of Phnom Kulen Mts. It flows through an open area with fields and plantations (Fig. 13). It is shallow, fast and clear, the bottom clayey, red, mostly firm but at some places sticky. The river bed is converted into a rice field so that rice grows immediately from shallow branching streams. Upstream of the road the river becomes deeper and narrow, further upstream there is a small dam and a pond. 12 km NEE of Phnom Peung Tanon Resort, 13.724–727°N, 103.849–850°E, 106–108 m a.s.l. Examined by O.K. on 11.12.2019.

Loc. 2 (Peung Tanon brook): an overgrown brook among cassava fields at the foothill of the western spur of the western plateau in the Phnom Peung Tanon Resort environs. The water is hidden under bushes woven by winding plants including ferns, with few tiny open pools. The downstream end of the examined part is more open, approached by forest remnants at the high right bank. 13.717–719°N, 105.853–855°E, 117–122 m a.s.l. Examined by O.K. on 11.12.2019.

Loc. 3 (Kbal Spean River valley): the Kbal Apean River valley downstream of the linga carvings, flowing (sometimes disappearing) through a natural staircase of large sandstone rocks in lush evergreen forest. There is a small waterfall just downstream of the carvings. 13.6846–6860°N, 104.016–017°E, 185–192 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Loc. 4 (upstream of Kbal Spean): the Kbal Spean River valley upstream of (Fig. 14) and at (Fig. 12) the carvings, flowing calm and flat half-shaded by pristine evergreen forest (rather open at the carvings). The water is clear, the depth varies from very small on sandy and flat stone bottom to knee deep, in such deep places with much litter and sucking silt. The course is frequently crossed by fallen trees and rattans. Some small patches of Colocasiae indet. and *Lasia spinosa* (L.) Thwaites at banks. 13.686–692°N, 104.013–017°E, 192–212 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Loc. 5 (Kbal Spean headquarters): the same rivulet as above flowing along the eastern plateau foothills, at the national park entrance, having just left the mountains;

Figure 14. The Kbal Spean River on the western Phnom Kulen Plateau upstream of the carvings (Loc. 4), 14.06.2018, O.K. Habitat of V. gracilis, Euphaea sp., H. biforata, R. viridatum, C. vittata, P. verticalis sensu Asahina, Gomphidia sp., M. rapida, R. obsolescens **etc.**

hidden in tall grass including Colocasiae indet. 13.679–680°N, 104.023–026°E, 78–80 m a.s.l. Examined by O.K. on 14.06.2018; 6.11.2018.

Eastern plateau

Loc. 6 (upstream of carvings): the shady reaches (Fig. 15) of the Prey Thom (O'Dar, Siem Reap) River reaches upstream its reach with linga carvings, evergreen forest (seemingly secondary), 750–1400 m SW the waterfall, 650–1000 m W-SW Preah Ang Thom. A medium-sized, moderately fast shallow river, most of the day shaded, with a sandy bottom and low earthy bluffs at banks. Some open places at the left bank. There is a spring being a small deep roundish pool, devoid of any vegetation, with ice-cold water visibly going from the pale-grey bottom (Fig. 16). 13.560–567°N, 104.100–102°E, 290–295 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 4.11.2018.

Loc. 7 (carvings): the Prey Thom (O'Dar, Siem Reap) River reach ('the River of 1000 Linga') with linga carved in the bottom (Fig. 8), surrounded by evergeen forest, 500–750 m SW the waterfall, 350–650 m W-SW Preah Ang Thom. The river bed mostly open and sunlit. Just downstream the bridge the right bank outlines an open area 270×100 m of flat sandstone rocks. There the river is very shallow and slow; then it passes rapids and a considerable ledge (Fig. 17) and then flows fast over rocks, in shade. There is a tiny but not so shallow roadside pool with *Nymphaea* sp. on the open flat rocks. Behind the rocky area there are secondary thickets with thorny bushes, small glades and ancient ruins. 13.565–567°N, 104.102–105°E, 280–290 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 17.06.2018; 4.11.2018.

Loc. 8 (Kulen Waterfall): the well-known waterfall on the Prey Thom (O'Dar, Siem Reap) River, 500 m N of Preah Ang Thom (Fig. 6). Two tiers, the higher some 5 and the lower some 30 m high, a big pool under the latter, with big boulders at its banks; evergreen forest on the valley slope; small glades and an open trading area above, 13.568–569°N, 104.106–108°E, 270–290 m a.s.l. Examined by O.K. on 23.02.2017; 11-12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018.

Loc. 9 (downstream of Kulen Waterfall): the rapidous Prey Thom (O'Dar, Siem Reap) River flowing in evergreen forest downstream the waterfall; moderately fast to fast, depth variable, large solitary rocks, an open place with a high ledge. 500-800 m N–NNE of Preah Ang Thom, 13.569–572°N, 104.108–109°E, 250–270 m a.s.l. Examined by O.K. on 11.06.2018; 17.06.2018; 30.06.2018.

Loc. 10 (2nd bridge): the right bank of the Prey Thom (O'Dar, Siem Reap) River flowing in evergreen forest remnants between the second bridge and the brook mouth at its left bank; shady downstream of the bridge and open for some distance upstreams (Fig. 18). Rather shallow, speed moderate. 1.2 km SE of Preah Ang Thom, 13.5532–5548°N, 104.1167–1181°E, 298–300 m a.s.l. Examined by O.K. on 12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018.

Loc. 11 (Kulen brook): an overgrown brook, the left Siem Reap River tributary, flowing through evergreen forest remnants and small cashew plantations, with clear, slightly brownish water. Mostly overgrown with walls of thick and tall vegetation (in more open places at the lowermost reach represented mostly by forked fern). There is an open pool at the road to village Thmei, through which the brook flows through three

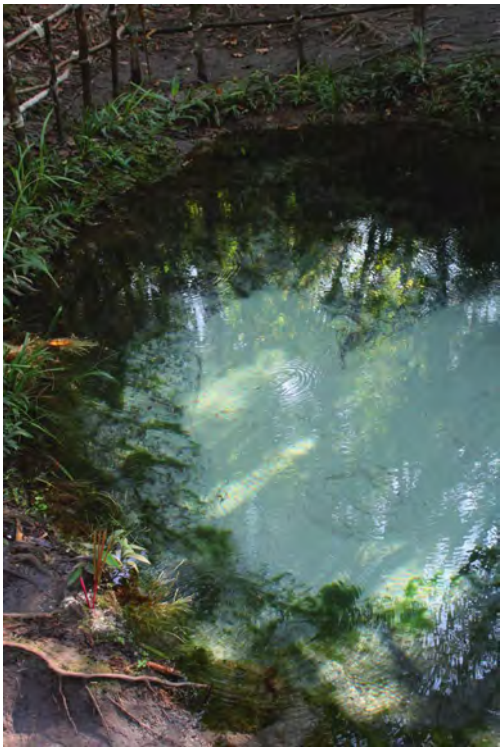

Figure 15. A shady reach of of the main river of the eastern plateau of Phnom Kulen (the Siem Reap River) upstream of the linga carvings, flowing through secondary forest (part of Loc. 6), 12.06.2018, O.K. Habitat of D. gloriosa, H. biforata, L. hyalina, R. viridatum, L. nodalis, A. rubescens, P. pruinosum, P. williamsoni, C. marginipes, M. alani, Onychothemis testacea, O. chrysis, R. obsolescens, Z. iris **etc.**

Figure 16. A cold spring at the shady bank of the Siem Reap River upstream of the linga carvings (part of Loc. 6), 4.11.2018, O.K. At this spring single males of Brachygonia oculata **were twice registered by E.S., on 24.07.2015 (Fig. 55b) and 6.10.2015.**

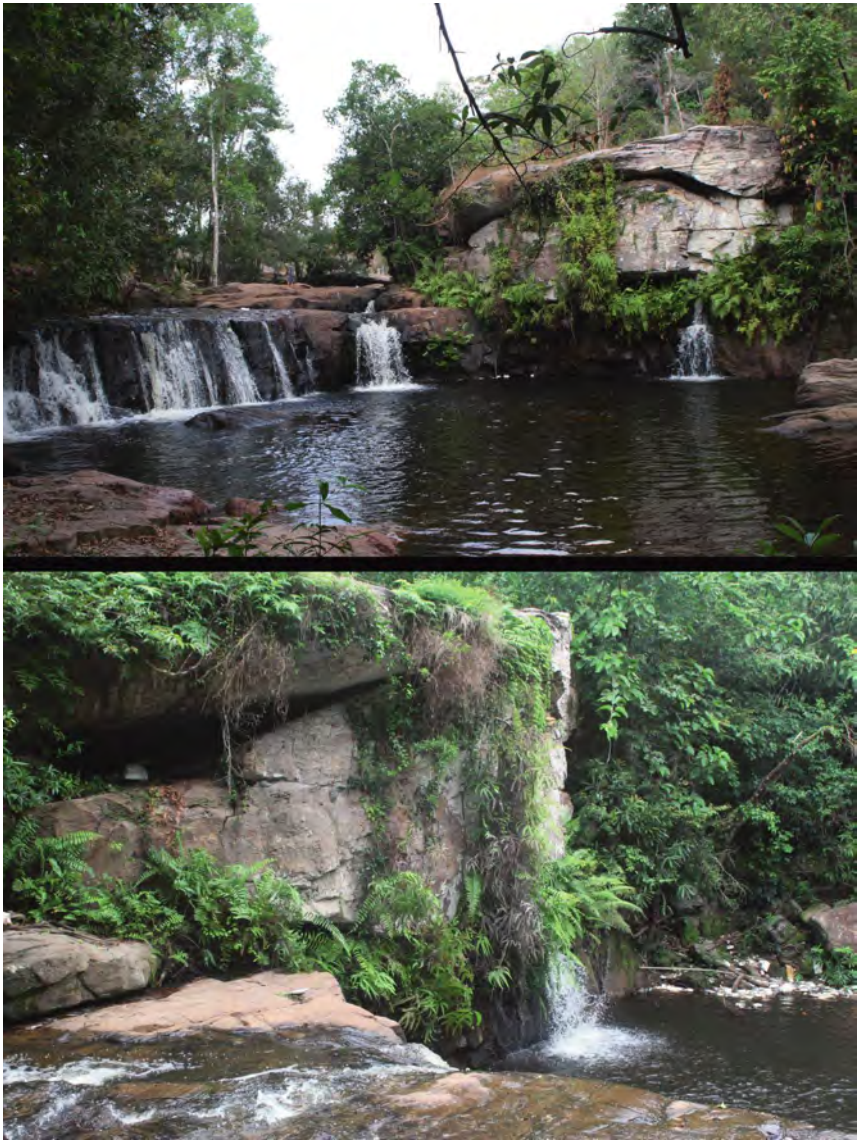

Figure 17. The ledge at the Siem Reap River downstream of the linga carvings (part of Loc. 7), 11.06.2018, O.K. Habitat of N. chinensis, V. gracilis, D. gloriosa, Euphaea sp., H. biforata, P. verticalis **sensu Asahina,** T. aurora, Z. iri**s etc.**

pipes ca 1.5 km in diameter, from which the water is seeping over algae-clad concrete plate. The upper reaches crossed by many fallen trees and rattans, with sandy bottom but silty deep places (Fig. 19). The lowest reach downstream of the road

Figure 18. The shady reach of the Siem Reap River downstream of the 2nd bridge (Loc. 10), 4.11.2018, O.K. Habitat of N. chinensis, V. gracilis, D. gloriosa, Euphaea sp., H. biforata, C. marginipes, Gomphidia sp., B. contaminata, Onychothemis testacea, O. chrysis **etc.**

Figure 19. The brook of Loc. 11 hidden in evergreen forest remnants, 4.11.2018, O.K. Habitat of V. gracilis, L. hyalina, A. pallidum, A. viola, M. aborense, C. marginipes, C. vittata, P. verticalis **sensu Asahina,** M. alani, Nannophya pygmaea, N. fluctuans, O. pulcherrima, O. chrysis, R. obsolescens **etc.**

Figure 20. The lowermost reach of the brook of Loc. 11 with round holes in its sandstone bottom, in the dry season, 10.03.2019 (left) and the rainy season, 12.06.2018 (right); **O.K. A possible breeding site of** Gynacantha subinterrupta, Idionyx thailandica **and** Macromidia rapida**.**

over flat sandstone rock with big (up to a metre in diameter) and deep round holes (such holes are made by harder stones lying on sandstone and moved by the current) (Fig. 20). At the end of the dry season, in March 2019, the brook was completely dried out, with some water left only in the round holes. Among the best places. 1.2–1.9 km SE of Preah Ang Thom, 13.553–554°N, 104.117–120°E, 301–330 m a.s.l. Examined by O.K. on 12.06.2018; 17.06.2018; 30.06.2018; 4.11.2018, 30.11.2019.

Loc. 12 (upstream of 2nd bridge): the Prey Thom River (O'Dar River, Siem Reap River) ~2 km SE of Preah Ang Thom. Most open and sunny, partly shaded river with a slow to fast but smooth current (Fig. 21), from knee-deep to waist deep, in some places man height deep. The bottom is formed by flat sandstone rocks, with sandy patches, the banks are overgrown with Poaceae grass and some Colocasiae. Near the upstream part of the studied section there is a ledge with a low 'waterfall', at which a brook enters from the left side. Upstream of this place the river flows broadly and very slowly. Some cashew plantation at the left bank and a recently cleared area at the right bank. One of the richest dragonfly places. 13.5547–5560°N, 104.1211–1266°E, ~300 m a.s.l. Examined by O.K. on 4.11.2018, 30.11.2019.

Figure 21. The half-shaded calm reach of the Siem Reap River upstream of the second bridge (Loc. 12), 11.03.2019 (top), 4.11. 2018 (middle), 30.11.2019 (bottom), O.K. Habitat of N. chinensis, V. gracilis, H. biforata, L. hyalina, L. lineata, R. viridatum, A. rubescens, P. australasiae, P. rubriceps, P. pruinosum, P. williamsoni, C. vittata, P. verticalis sensu Asahina, P. ciliata, P. capricornis, M. cupricincta, A. panorpoides, B. contaminata, D. nebulosa, N. fluctuans, Onychothemis testacea, R. rufa, R. phyllis, R. triangularis, R. variegata, T. aurora, Zygonyx iris **etc.**

Figure 22. A brook flowing over an open area of flat sandstone rocks (loc. 'veal') on the eastern Phnom Kulen plateau 1.5 km SE of Thmei village (Loc. 13). 30.06.2018, O.K. Habitat of V. gracilis, P. verticalis sensu Asahina, N. fluctuans, O. chrysis, Z. iris **etc.**

Figure 23. The bottom of the Srae Tbong former reservoir, with a river flowing through swampy grassland (part of Loc. 15). 28.11.2019, O.K. Habitat of A. minima, D. nebulosa, O. luzonicum, P. sexmaculata **etc.**

Loc. 13 (veal brook): an overgrown brook on a savannah clad, nearly barren sandstone plateau ('veal') 1.7 × 1 km, 1.5 km SE of Thmei village. A chain of pools, up to knee-deep, over sandstone. Downstream of the road the brook flows shallowly over flat sandstone rocks, with some deeper pools; hidden in low and thick forest patch (Fig. 22). Upstream of the road there is at first a long waist-deep shady reach, further upstream

it flows in a 'channel' of thick low bushes and low trees, knee-deep, mostly filled with a fine Poacae grass. Curiously, although this brook flows amidst dry barren rock plates, it had hardly less amount of water in the late dry season (March 2019) than in the rainy season (June 2018). 13.523–524°N, 104.119–121°E, 320–326 m a.s.l. Examined by O.K. on 30.06.2018, 11.03.2019.

Loc. 14 (forest border): the valley of the stream flowing from the three next localities, to join the Siem Reap River in 150 m, along the border of the protected Prey Thom Forest and a cashew plantation area; here crossed by the road from Preah Ang Thom to Anlong Thom; 13.548-549 N, 104.147-148 E, 313-325 m a.s.l.. No water in the dry season. Examined only by E.S. on 3.12.2018 and 7.12.2018.

Loc. 15 (Srae Tbong): 1.9 km SW of Anlong Thom village, the E margin of a former large (700×600 m) reservoir called Srae Tbong, now filled with open grassy floating bog, with hanging grass matts soaked with water of numerous river arms flowing through (Fig. 23). Some trees and a rice field at margins. 13.5234–5240°N, 104.1574–1582°E, 332–335 m a.s.l. Examined by O.K. on 28.11.2019.

Loc. 16 (Srae Tbong River): the medium-sized river flowing from the previous place (Loc. 15) to the next place (Loc. 17). from ankle- to neck-deep, with partly firm and partly sucking bottom, bordered by trees. Examined by O.K. on 28.11.2019 downstream (north) of the bridge and the broken dam of Srae Tbong, 13.5258–5269°N, 104.1558–1564°E, 333–335 m a.s.l. E.S. examined a nearby patch of the swamped forest, similar to that of the next locality (Loc. 17) at the dam (13.5256-5259°N, 104.1558-1564°E) on 28.07.2019, 27.10.2019 and 7.11.2019.

Loc. 17 (Tnal Mareh): 1.3 km SW of Anlong Thom village, Rong Chen Archaeological Protected Area, Tnal Mareh terrain, the place of the ancient ceramic factory founded in the first years of IX century. A broad (240×150 m) depression (perhaps the former source of clay for the factory) filled with a shady, low 'floating forest' swamped with a branching rivulet, presumably dominated with *Rhizophora* sp., with numerous pointed pneumatophores as at seaside mangroves (Fig. 7). The rivulet arms up to waist-deep, some nearly stagnant, some with a fast current. A more open shallower channel, bordered with bushes, 100 m long, goes at right angle to the river course. A narrow (145×15 m) boggy pasture (a former rice field) with spikerush nearby. The slightly elevated right bank occupied with evergreen forest, with the soil filled with numerous ceramic shards, often finely ornamented (Fig. 10). A bushy pasture at the left bank. 13.528–530°N, 104.157–160°E, 333–336 m a.s.l. Examined by O.K. on 28–30.11.2019.

Loc. 18 (cashew): 600 m NW of Anlong Thom village, the O'Dar River smoothly flowing among remnants of forest trees through cashew plantations over even flat sandy bottom, half-shaded by forest trees. 13.5412–5417°N, 71 104.1628–1638°E, 325–328 m a.s.l. Examined by O.K. on 10.03.2019.

Loc. 19 (Anlong Thom): 500 m NE of Anlong Thom village. The O'Dar River flowing shallowly over a sandstone bed by a big open savannah-like glade, evergreen forest remnants and a cashew plantation. The following reaches change from one to another from downstream to upstream: (i) a riffly part by cashew plantation, used by locals for washing, (ii) a waist-deep long pool, (ii) a long curious reach with water seeping over very smooth slanting rock covered with wet water moss, (iv) a very shallow reach flowing over flat sandstone plate, with a tall 'wall' of forked fern at the

Figure 24. The dam of the Tnal Dach Reservoir (Loc. 20). (The bottom photo shows Nepenthes mirabilis **floating in water along with the aquatic carnivorous plant** Utricularia aurea**). 29.11.2019, O.K.**

right bank and forest remnants at the left bank, (v) a shaded deep reach under tree canopy, (vi) a small rather dirty pond (again used by locals for washing) behind a small low dam (vii) further upstream the river. hidden in scrub, narrowly flows through a chain of pools. Among the best places. 13.541–542°N, 71 104. 168–170°E, 336–340 m a.s.l. Examined by O.K. on 10.03.2019, 28–29.11.2019.

Loc. 20 (Tnal Dach): 800 m NE of Anlong Thom village, Tnal Dach Reservoir (320 ×300 m) (Fig. 11). Its dam was destroyed by American bombing and restored in 2012. A long and high dam with tall trees (Fig. 24), a cashew plantation below it. At the dam the depth varies from chest to man height; the banks are steep, densely overgrown with Poaceae, *Cyperus* and *Lygodium*; there are some small islands of the same vegetation (Fig. 25b). The lateral banks are shal-

Figure 25. The Tnal Dach Reservoir (Loc. 20): the river outlet (a), the steep grassy bank at the dam (b) and a shallow S bank (c). 29.11.2019, O.K. Habitat of A. borneense, C. cerinorubellum, P. calamorum, P. australasiae, P. williamsoni, O. atrocyana, P. ciliata, I. decoratus, A. panorpoides, A. gracilis, B. chalybea, B. farinosa, B. sobrina, C. servilia, D. nebulosa, H. croceus, I. limbata, Nannophya pygmaea, N. fluctuans, O. sabina, T. pallidinervis, R. phyllis, R. triangularis, U. signata **etc.**

Figure 26. Grass and bushes over shallow running water at the Tmar Truonh terrain (Loc. 21). 29.11.2019, O.K. Habitat of V. gracilis, A. femina, A. minima, C. cerinorubellum, P. williamsoni, P. ciliata, D. nebulosa, Nannophya pygmaea, N. fluctuans, O. luzonicum **etc.**

low, with quite a lot of dead trees standing in the water (which grew there before the dam was restored). At the northern end of the dam a concrete outlet (Fig. 25a) is constructed of the Prey Thom, O'Dar River, or Siem Reap River (Locs 6-10, 12, 18-19), here rather a small rivulet flowing in a deep shady valley. At this place the reservoir is shallow and its bottom sandy and firm. There is a very shallow bay at the

S dam corner, with emerging Poaceae and Cyperaceae grass (Fig. 25c) and then *Nepenthes mirabilis* (Lour.) Rafarin floating in water side-by-side with *Utricularia aurea* Lour. (Fig. 24, bottom). At the dam northern end there is an isolated shallow pool with golden fishes. The northern bank is densely overgrown with tall grass and somewhat swampy. Among the best places. 13.5395–5423°N, 104.1730–1758°E, 344–348 m a.s.l. Examined by O.K. on 28–29.11.2019.

Loc. 21 (Tmar Truonh): 1.5 km W of Tmar Thruonh village, Srae Tmar Truonh terrain. A big (320×160 m) open area occupied with rice fields. The above mentioned O'Dar (Prey Thom or Siem Reap) River outlines its northern margin. It is hidden by trees, braided with winding ferns, and forms a grassy floating bog like at Loc. 15, with hanging grassy mats soaking with water (Fig. 26) and alternating with narrow courses of fast flowing clear water. 13.5383–5385°N, 104.1808–1820°E, 351–353 m a.s.l. Examined by O.K. on 29.11.2019.

Loc. 22 (Sangkae Leak village environs); a small stream with cold and very clean water and solid bottom of small stones and sand, the valley shaded by trees. 13.5642-5646 N, 104.1955-1956 E, 352 m a.s.l. Examined only by E.S. on 25.11.2019.

Figure 27. The Siem Reap River at the first bridge after its leaving the eastern plateau of Phnom Kulen for the lowland, 2.5 km SE of Khum village (Loc. 25). 2.12.2019, O.K. Habitat of D. gloriosa, L. lineata, P. australasiae, P. rubriceps, P. williamsoni, P. autumnalis, P. coerulescens, Burmagomphus **sp. cf.** williamsoni, M. kerri, C. servilia, O. chrysis, O. neglectum, T. aurora, T. festiva **etc.**

Figure 28. The Siem Reap River upstream of (a), at (b) and downstream of (c) the bridge in Banteay Srei village (Loc. 26); **a – 1.07.2018**; **b-c - 2.12.2019, O.K. Habitats of** N. chinensis, V. gracilis, D. gloriosa, L. lineata, P. williamsoni, C. malaisei, P. autumnalis, P. coerulescens, P. ciliata, E. yunnanensis, I. decoratus, M. kerri, P, capricornis, M. aculeata, B. contaminata. D. trivialis, C. servilia, N. fluctuans, N. fulvia, Onychothemis testacea, O. chrysis, O. neglectum, O. sabina, T. aurora **etc.**

Loc. 23 (Ta Penh): 500–600 m N of Ta Penh village. A brook passing, under trees, a gap in an ancient dam, crossing a big pasture and then running along a scrub with trees and forked fern, then entering it. Mostly shallow, at some places boggy, amidst a pasture there is a big grassy widening. 13.5555–5571°N, 104.2115–2139°E, 365–367 m a.s.l. Examined by O.K. on 10.03.2019.

Loc. 24 (Thma Dab Temple): 150 m E of the Thma Dab Temple ruins, a small and very clean stream in a very thick, hardly penetrable forest. There is some water even in the dry season. Soil sandy with just a bit of mud and no rocks. 13.5016 N, 104.1609-1610 E, 344 m a.s.l. Examined by E.S. on 14.03.2020.

Additional localities at the Siem River reaches shortly downstream of its descend from the mountains to the lowland:

Loc. 25 (closest bridge): the Siem Reap River at the first bridge 5.5 km downstream of its leaving the mountains (Fig. 27). A long sunny reach, ankle to waist deep, surrounded by 'walls' of thick bushes and trees; some logs in water. Arable land, plantation and forest remnants around. 2.5 km SE of Khum village, 13.619–620°N, 104.006–007°E, 60 m a.s.l. Examined by O.K.: 2.12.2019.

Loc. 26 (Banteay Srei): the considerable Siem Reap River at the bridge in Banteay Srei village (Fig. 28). The bottom is sandy with some stones (under the bridge they are piled deliberately); the current is fast (at narrower parts hard to go against it) but smooth. Upstream of the bridge the river is open, mostly shallow but with some man-height deep places (Fig. 28a); downstream of the bridge from knee- to waist-deep and mostly shady (Fig. 28c). The sandy banks are overgrown with giant spiny bamboo and other thickets; the right bank with a shallow bay with a patch of fine inundated grass and *Marsilea* sp.. 2.3 km W of Phnom Diy Hill, 13.5950–5965°N, 103.9613–9623°E, 51-52 m a.s.l. Examined by O.K.: 11-12.06.2018; 14.06.2018; 1.07.2018; 3.11.2018; 2.12.2019.

Annotated checklist of Odonata of Phnom Kulen

Calopterygidae

1. *Neurobasis chinensis* (Linnaeus, 1758)

O.K.: **Loc. 7**: 23.02.2017: several ♂♂ seen; 11.06.2018: several ♂♂, ♀♀ seen. **Loc. 8**: 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many ♂♂, ♀♀ seen. **Loc. 10:** 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many ♂♂, ♀♀ seen. **Loc. 12:** 4.11.2018: several ♂, 1 ♀ seen; 11.03.2019: several ♂♂, ♀♀ seen below the small waterfall; 30.11.2019: several ♂♂, ♀♀ seen. **Loc. 26**: 14.06.2018: many ♂♂, several ♀♀ seen; 1.07.2018: several ♂♂ seen; 3.11.2018: 1 ♂ seen; 6.11.2018: 1 ♂ seen.

E.S.: **Loc. 12:** 22.12.2019: ♂. Not located: 4.12.2018: ♂.

Observations. Occurs at half-shaded rivers with fast or slightly turbulent current. Common but not numerous. So far registered only along the main river of the eastern plateau (O'Dar, Prey Thom, or Siem Reap), including its course after leaving the plateau for the plain but still close to it. Active until dusk.

2. *Vestalis gracilis* (Rambur, 1842)

O.K.: **Loc. 3**: 14.06.2018: many seen. **Loc. 4**: 14.06.2018: several seen ; 6.11.2018: many seen. **Loc. 5**: 14.06.2018: several seen. Locs 6-7: 23.02.2017: many ♂♂, ♀♀ seen (wingtips clear); 11.06.2018: very many ♂♂, ♀♀ seen (wingtips darkened). **Loc. 7**: 4.11.2018: several seen. **Loc. 8**: 12.06.2018: many seen; 17.06.2018: many seen; 30.06.2018: many seen; 4.11.2018: many seen; 10.03.2019: many seen. **Loc. 10:** 17.06.2018: many seen; 30.06.2018: many seen; 4.11.2018: many seen. **Loc. 11:** 12.06.2018: many ♂♂, ♀♀ seen (wingtips dark); 17.06.2018: very many ♂♂, ♀♀ seen; 30.06.2018: very many seen; 4.11.2018: many seen; 10-11.03.2019: very many seen; 30.11.2019: several seen. **Loc. 12:** 4.11.2018: many seen; 11.03.2019: very many seen; 30.22.2019: several seen. **Loc. 13**: 30.06.2018: several seen; 11.03.2019: many seen. **Loc. 17**: 29.11.2019: several seen. **Loc. 18**: 10.03.2019: many seen. **Loc. 19**: 10.03.2019: many seen; 28.11.2019: several seen; 29.11.2019: many seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 23**: 10.03.2019: several seen. **Loc. 26**: 14.06.2018: several seen; 1.07.2018: several seen; 3.11.2018: 2 ind. seen.

E.S.: **Loc. 6**: 23.02.2017: ♂, ♀; 16.03.2018: ♀; 4.11.2018: ♂. **Loc. 10:** 20.03.2018: ♂; 4.12.2018: sex uncertain. **Loc. 12:** 13.12.2018: ♂♂; 16.12.2018: ♂. **Loc. 13**: 22.07.2019: ♂. **Loc. 14:** 7.12.2018: sex uncertain. **Loc. 15:** 27.10.2019: ♂; 7.11.2019: ♂♂. **Loc. 18**: 10.03.2019: ♂. **Loc. 19**: 5.03.2019: ♀; 14.05.2019: ♀. Not located: ♂; 6.10.2015: ♂; 15.06.2017: ♂; 18.05.2018: ♀; 28.07.2018: ♂; 4.12.2018: ♂; 22.12.2018: ♂; 7.03.2019: ♂; 12.04.2019: teneral ♂; 24.04.2019: ♂.

Remarks. At Locs 6-7 these demoiselles had clear wingtips in February 2017 but dark wingtips in June 2018 (in other cases this character was not recorded). This is in line with a supposition that imagines with dark wingtips result from larvae developed in late dry season (February/April) which is the hottest time of the year (Kosterin 2011).

Observations. One of the commonest and most abundant Odonata. Imagines congregate at tree-shaded shrubs by banks of small and medium forest rivers.

Euphaeidae

3. *Dysphaea gloriosa* Fraser, 1938 (Fig. 29)

O.K.: **Loc. 6**: 11.06.2018: 1 ♂ seen; 12.06.2018: 2 ♂♂ seen. **Loc. 7**: 11.06.2018: 1 ♂ photo. **Loc. 8**: 12.06.2018: very many ♂♂ seen; 17.06.2018: 2 ♂♂ collected, many ♂♂ seen; 30.06.2018: 1 ♂ collected, very many ♂♂ seen. **Loc. 10:** 12.06.2018: 1 ♂ collected, 2 more ♂♂ seen; 30.06.2018: several ♂♂ seen. **Loc. 25:** 2.12.2019: 1 ♂ photo. **Loc. 26**: 1.07.2018: several ♂♂ seen.

E.S.: **Loc. 10:** 18.05.2018: ♂. **Loc. 25:** 30.05.2019: ♂. Not located: ♂; 15.06.2017: ♂.

Observations. At Loc. 8 on 12.06.2018, at 8:45 a.m. O.K. saw only two males at the rocks below the waterfall, but many of those appeared between 9:30 and 10 a.m.; they perched on rocks or, less frequently, on branches, fought with each other and became not too cautious. They remained active until twilight ca 5:30 p.m. In non-rocky river reaches the males invariably occupy dry branches (either thick or thin) of fallen trees in or near the river (Fig. 29).

Figure 29. A male of Dysphaea gloriosa **perching on a log at the first bridge of the Siem Reap River after its leaving the Phnom Kulen eastern plateau (Loc. 25), 2.12.2019, O.K.**

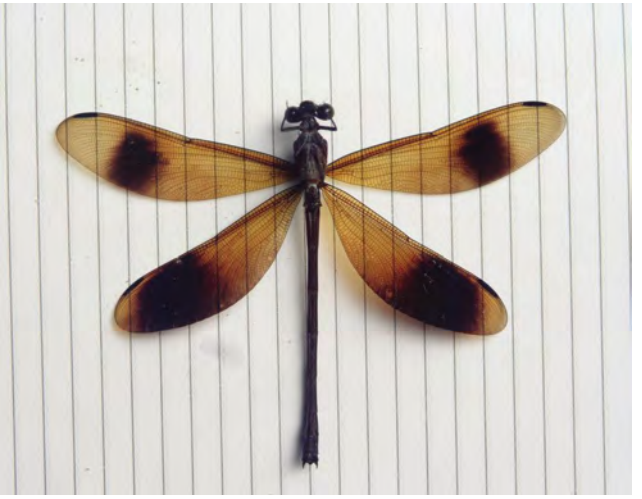

Figure 30. A male of Euphaea **sp. from the Siem Reap River at its ledge downstream of the carvings (Loc.7). Line space 5 mm. 11.06.2018, O.K.**

4. *Euphaea* sp. (Figs 30-33)

O.K.: **Loc. 3**: 14.06.2018: 8 ♂♂, 2 ♀♀ collected, 1 ♂ photo (Fig. 32b), very many ♂♂ seen. **Loc. 4**: 14.06.2018: very many ♂♂ seen; 6.11.2018: 1 ♀ collected, several ♂♂ seen. **Loc. 7**: 23.02.2017: 1 ♂ collected (Fig. 30); 11.06.2018: 4 ♂♂ collected, 1 ♂ photo (Fig. 31a), 1 ♀ photographed (Fig. 33b) and collected, many ♂♂ seen. **Loc. 8**: 12.06.2018: 4 ♂♂, 1 ♀ collected, 1 ♂ photo (Fig. 31b), many ♂♂seen; 17.06.2018: many ♂♂ seen; 30.06.2018: several ♂♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 10:** 12.06.2018: many ♂♂ seen; 17.06.2018: many ♂♂ seen; 30.06.2018: many ♂♂ seen; 4.11.2018: many seen. **Loc. 11:** 12.06.2018: several ♂♂ seen; 17.06.2018: several ♂♂ seen; 30.06.2018: several ♂♂ seen; 10.03.2019; 11.03.2019: 1 ♂ seen: 1 ♂ seen. **Loc. 12:** 4.11.2018: 1 ♂ collected, several ♂♂ seen; 11.03.2018: 1 ♂ seen at the small waterfall; 30.11.2018: several ♂♂ seen at the same place.

E.S.: **Loc. 10:** 20.03.2018: ♂ (Fig. 31c); 4.11.2018: ♂; 18.05.2018: ♂. **Loc. 12:** 22.12.2018: ♂ (Fig. 32a); 14.05.2019: ♀ (Fig. 33a). Not located: 30.04.2015**:** ♂; 19.04.2017: ♂.

Remarks. The *Euphaea* species inhabiting Phnom Kulen is similar to *E. masoni* Selys, 1859 but the males of *E. masoni* have the distinct borders of the black areas in their wings (see e.g. Kosterin 2012: fig. 43) while in all Phnom Kulen males the dark (blackish-brown) coloration, with seemingly the same total amount of melanin, is 'dissolved' over the wing area (Figs 30-31). Both sides of their wings also show a mixture of bluish-green and purple reflections (Fig. 32), versus a dull purple reflex on the upperside only in males of *E. masoni*. Such 'dissolved' males (Kosterin 2017: figs 21, 22a-b) also occur in Stung Treng Province (east of Phnom Kulen, along the Mekong River) at a frequency comparable with that of males with the distinct wing pattern typical for *E. masoni* (Kosterin 2017: fig. 22c). This can be interpreted as either two distinct morphs of the same species, perhaps monogenically controlled, with the 'dissolved' allele fixed in the Phnom Kule population, or as two sympatric species, with Phnom Kulen as the core area for the undescribed 'dissolved' one. The issue is complicated by rare occurrence of 'discoloured' males, with the wings not only missing distinct spots but also much less melanised on average, across the range of *E. masoni* (Hämäläinen et al. 2019), see an example in Kosterin (2011**:** fig. 69).

Mature males of *E. masoni* have the face entirely glossy-brownish-black. Those of the related species *Euphaea cyanopogon* Hämäläinen, Kosterin et Kompier, 2019, recently described from Kampongsaom Peninsula and Phu Quoc Island, with discoloured wings, have two indistinct pale spots on the labrum (Hämäläinen et al. 2019). The males from Phnom Kulen exhibit a range of variation between these versions of the labrum coloration: from entirely glossy brownish-black (in about half of male specimens) through having two brownish lightening at the labrum upper margin to the labrum with a pair large yellowish triangular spots. It is unclear if this variation is age-related (there is no noticeable difference in the otherwise phenotype), and if the same variation exists in 'true' *E. masoni*.

Molecular studies, hopefully focused on more than one sequence, could shed light on the taxonomic status of the Phnom Kulen population.

Figure 31. Males of Euphaea **sp.: a - from the Siem Reap River at its ledge downstream of the carvings (Loc.7), 11.06.2018, O.K.; b – from below the waterfall on the same river (Loc. 8), 12.06.2018, O.K.; c – at the second bridge of the same river (Loc. 10), 20.03.2018, E.S.**

Figure 32. Males of Euphaea **sp. with half-open wings: a - from the Siem Reap River upstream of the 2nd bridge (Loc. 12), 22.12.2018, E.S.; b – from the Kbal Spean River downstream of the carvings (Loc. 3), 14.06.2018, O.K.**

Observations. Occurs only at streams with rocky bed and at least somewhat turbulent water. Prefers to perch on branches (Figs 31a,c, 32), especially females (Fig. 33) but can also occupy stones (Fig. 31b), although less readily than the previous species.

Figure 33. Females of Euphaea **sp.: a – upstream of the second bridge the Siem Reap River (Loc. 12), 14.05.2019, E.S**; **b - from the ledge of the same river downstream of the carvings (Loc.7), 11.06.2018, O.K.**

Chlorocyphidae

5. *Heliocypha biforata* (Selys, 1859)

O.K.: **Loc. 3**: 14.06.2018: 1 ♂, many ♂♂, ♀♀ seen; 6.11.2018: 1 ♂ photo, several more ♂♂ seen. **Loc. 4**: 14.06.2018: 1 ♂ photo, very many ♂♂, ♀♀ seen; 6.11.2018: 1very many ♂♂, ♀♀ seen. **Loc. 5**: 14.06.2018: several ♂♂ seen; 6.06.2018: many ♂♂, ♀♀

seen. **Loc. 6**: 23.02.2017: several ♂♂, ♀♀ seen. **Loc. 7**: 23.02.2017: 1 teneral ♂ collected, several ♂♂, ♀♀ seen; 11.06.2018: 5 ♂♂ collected, many ♂♂, ♀♀ seen; 4.11.2018: several seen. **Loc. 8**: 12.06.2018: 1 ♂ photo; many ♂♂, several ♀♀ seen; 17.06.2018: 2 ♂♂ collected, many ♂♂ seen; 30.06.2018: very many ♂♂ seen; 4.11.2018: many seen. **Loc. 10:** 12.06.2018: very many ♂♂, ♀♀ seen; 30.06.2018: many seen; 4.11.2018: many seen; 10.03.2019: many seen. **Loc. 11:** 12.06.2018: many ♂♂, ♀♀ seen; 17.06.2018: many seen; 4.11.2018: many seen; 10-11.03.2019: several seen; 30.11.2019: several immature ♂♂ seen. **Loc. 12:** 4.11.2018: many seen; 11.03.2019: very many seen; 30.11.2019: 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 18**: 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 6**: 23.02.2017: ♂, ♀; 4.11.2018: ♂; 3.12.2018: ♀; 13.12.2018: ♂, ♀; 15.05.2019: ♀. **Loc. 10:** 20.03.2018: ♂, ♀; 11.04.2018: ♂♂; 19.04.2018: ♂; 18.05.2018: ♂, tandem; 4.11.2018: ♂♂; 3.12.2018: ♀. **Loc. 12:** 13.12.2018: ♂; 16.12.2018: ♂; 22.12.2018: ♀. **Loc. 19**: 14.05.2019: ♀. **Loc. 25:** 29.04.2019: ♂; 27.11.2019: ♂, ♀. E.S.: **Loc. 24:** 14.03.2020**:** ♂.

Not located: 23.02.2015**:** ♂; 15.05.2015: ♂; 11.04.2017: ♂♂; 27.04.2017: ♀; 7.03.2019: ♂ and teneral ♂; 12.04.2019: teneral ♂.

Observations. Very common round the year at banks of forest rivers and brooks. Elsewhere males of this species prefer to perch on vegetation and avoid stones, which are preferred by a congener *H. perforata* (Percheron in Guérin-Méneville & Percheron, 1835), hence demonstrating behavioural segregation with it (Kosterin 2011). However *H. perforata*, common elsewhere in Cambodia, is for some reason absent from Phnom Kulen. As a result, males of *H. biforata* can be equally often observed perching on stones (if any) at water course banks and so can be mistaken for *H. perforata* from distance. Hence in the situation of absence of the matching species the disruptive selection for behavioural differences is relaxed allowing it to be more flexible.

6. *Libellago hyalina* (Sely, 1959) (Figs 34)

O.K.: **Loc. 6**: 12.06.2018: 2 ♂♂ seen. **Loc. 11**: 12.06.2018: 3 ♂♂ collected; 17.06.2018: 2 ♂♂ collected, many seen; 30.06.2018: many seen; 4.11.2018: many ♂♂, ♀♀ seen. **Loc. 12:** 11.03.2019: 2 ♂♂ seen. **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19** (shady area): 10.03.2019: 1 ♂, 2 ♀♀ collected, several ♂♂ seen.

E.S.: **Loc. 10:** 4.11.2018: ♀. **Loc. 11:** 4.11.2018: ♂. **Loc. 12** (at a small brook, the left tributary of the main river): 16.07.2019: ♀ (Fig. 34a); **Loc. 20** (at the outlet): 7.11.2019: ♂ (Fig. 34b-c), ♀; **Loc. 25**: 29.04.2019: ♂; 15.05.2019: ♀. Not located: 4.11.2018: ♂.

Observations. Rather a small, obscure and elusive species preferring shaded streams from brooks to medium rivers. However, of 8 localities where it was found in Phnom Kulen, all at the eastern plateau, 7 were at the main river (known as Siem Reap River and other names), including Loc. 25 where it has already left the plateau for lowland, and only one (Loc. 11) at its smaller tributary. The preferred micro-habitats of this species are patches of flowing litter and foam accumulated at trunks or branches of trees fallen across rivers or brooks, as shown in Fig. 15.

Figure 34. Libellago hyalina**: a – female, upstream of the second bridge the Siem Reap River (Loc. 12), 16.07.2019, E.S**; **b-c – male, Tnal Dach Reservoir at the river outlet (Loc.20), 7.11.2019, E.S.**

7. *Libellago lineata* (Burmeister, 1839)

O.K.: **Loc. 5**: 6.11.2018: 1 ♂ seen. **Loc. 12:** 4.1.2018: 2 ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 19**: 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂, 1 ♀ seen. **Loc. 25:** 2.12.2019: many ♂♂, ♀♀ seen. **Loc. 26**: 12.06.2018: 1 ♂ seen; 14.06.2018: 1 ♂, 2 ♀♀ collected, many ♂♂, ♀♀ seen; 1.07.2018: 1 ♂ photo, many ♂♂, ♀♀ seen; 3.11.2018: 1 ♂ seen; 6.11.2018: 1 ♂ seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 7**: 28.07.2018: ♂♂, **Loc. 25:** 27.04.2019: ♂♂, ♀♀; 30.05.2019: ♂♂, ♀; Not located: 14.12.2018: ♂.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: 04-06.2013: ♂, ♀.

Observations. In contrast to its above congener, this species prefers lowland, sunny reaches of rivers, and avoids brooks and small rivulets. Its very motile bright yellow-and-black males are quite conspicuous in sunlit places they prefer. Females prefer to sit on thin branches, usually of bamboo, quite high over the water. Readily found in plenties at the Siem River or Kbal Spean Rivulet when they have left the mountains (Locs 5, 25-26) but is quite rarely met uphill (at the same Siem Reap River; locs 7, 12, 19).

Philosinidae

8. *Rhinagrion viridatum* Fraser, 1938 (Figs 35)

O.K.: **Loc. 4**: 14.06.2018: 2 ♂♂ seen; 6.11.2018: 3 ♂♂ collected, 3 ♂♂ photo (Fig. 35), very many ♂♂ seen. **Loc. 6**: 4.11.2018: 1 ♂ seen. **Loc. 12:** 4.11.2018: 1 ♂ collected. **Loc. 19**: 29.11.2019: 1 ♂ photo.

Figure 35. A male of Rhinagrion viridatum **at the Kbal Spean River upstream of the carvings (Loc. 4), 6.11.2018, O.K.**

Observations. Occurs at small rivers and in evergreen forest. On 6.11.2018 all along the Kbal Spean River upstream of the carvings (Loc. 6) O.K. observed an unprecedented abundance of males (Fig. 35) of this species: up to 2-3 on each sunlit bush at the banks. Twice he observed as two males matched with an agonistic behaviour like in chlorocyphids: they were hovering face-to-face over the river surface and swaying simultaneously.

Lestidae

9. *Lestes praemorsus decipiens* Kirby, 1893

E.S.: Not located: 15.05.2015: ♂.

Remarks. Although rather a common species elsewhere in Cambodia, recorded only once and only by photo without exact location.

10. *Lestes nodalis* Selys, 1891 (Fig. 36)

E.S.: **Loc. 6**: 22.12.2018: ♀ (Fig. 36).

Remarks. As the previous species, this one has been recorded only once and only by a photo (Fig. 36). There seem to exist two related species, *L. nodalis* and *L. garoensis* Lahiri, 1987, differing only in the shape of the male cerci, blunt versus pointed tips of the main cercus body as well as its inner inflation (Lieftinck 1960; Kosterin 2019a). *L. nodalis* was described from Lower Myanmar and its doubtless males have been twice reported for Thailand (Lieftinck 1960; Asahina 1983) while *L. garoensis* (= *L. nodalis* sensu Fraser, 1933 nec Selys), described from Meghalaya and Manipur States of India, is so far known only from India (Fraser 1933; Lahiri 1987; Kosterin 2019a). Since Myanmar and Thailand are much closer to Cambodia than India, we preliminarily identify the female photo from Phnom Kulen as *L. nodalis* rather than *L. garoensis*. Hopefully this record will later be confirmed by male specimen(s). *L. nodalis* has already been reported for Cambodia but, again, based on a (male) photo only (Kosterin et al. 2012), which would not allow distinguishing between *L. nodalis* and *L. garoensis*.

Figure 36. A female of Lestes nodalis **at the Siem Reap River upstream of the carvings (Loc. 6), 22.12.2018, E.S.**

Figure 37. Males of Aciagrion borneense**: a – at the shallow S bank of the Tnal Dach Reservoir (Loc. 20), 29.12.2019, O.K.; b – (see the black mark on S9) at the Siem Reap River upstream of the 2nd bridge (Loc. 12), 15.12.2018, E.S.**

Coenagrionidae

11. *Aciagrion borneense* Ris, 1911 (Fig. 37)

O.K.: **Loc. 20** (at a shallow bay): 29.11.2019: 1 ♂ collected; 1 ♂ photo (Fig. 37a).

E.S.: **Loc. 12:** 15.12.2018: ♂ (with a black mark on S9). **Loc. 14:** 3.12.2018: ♀.

Remarks. Some males have a black dorsal streak on S9. The same was observed at the Lake Tonle Sap N bank in the same province but not yet elsewhere in Cambodia. Laidlaw (1924) admitted possibility of presence of a dorsal black marking on S9 in males this species.

Observations. This mostly a dry season species was registered only in November and December and seems to be rather scarce in Phnom Kulen.

12. *Aciagrion pallidum* Selys, 1891

O.K.: **Loc. 4**: 6.11.2018: 1 ♀ collected, 1 more ind. seen. **Loc. 11** (a dry cashew plantation nearby): 4.11.2018: 1 ♂, 1 ♀ collected, 1 more ind. seen. **Loc. 17**: 28.11.2019: 1 immature ♂ released.

E.S.: **Loc. 12:** 14.12.2018: ♀; 16.12.2018: ♂, ♀; 22.12.2018: ♂.

Observations. This is also a dry season species (Fraser 1933) and it was also infrequently registered only in November and December, at different environments.

13. *Agriocnemis femina* (Brauer, 1868)

O.K.: **Loc. 21:** 29.11.2019: 4 ♂♂ collected, 1 ♂ photo, very many ♂♂, ♀♀ seen.

Observations. This species, so common elsewhere in E and SE Asia, for some reason is rarely met in Cambodia and was found only once in Phnom Kulen, although in big quantities and in the most fit habitat: fine emerging grass soaking with half-running water.

14. *Agriocnemis minima* Selys, 1877

O.K.: **Loc. 12:** 30.11.2019: 1 ♀ collected. **Loc. 15:** 28.11.2019: 1 ♂, 1 ♀ collected. **Loc. 17** (a grassy swamp): 28.11.2019: 1 ♀ collected. **Loc. 20:** 28.11.2019: 1 ♀ collected. **Loc. 21:** 29.11.2019: 5 ♂♂, 1 ♀ collected, very many ♂♂, ♀♀ seen. **Loc. 25:** 3.11.2018: 1 ♂ collected.

E.S.: **Loc. 20:** 5.11.2019: ♂, immature (red) ♀, 25.11.2019: ♀.

Observations. The most common and widespread *Agriocnemis* species in Siem Reap Province in general and in Phnom Kulen in particular; found in emerging fine grass at different water bodies.

15. *Agriocnemis nana* (Laidlaw, 1914)

O.K.: **Loc. 1**6: 28.11.2019: 1 ♀ collected. **Loc. 17** (a grassy swamp): 28.11.2019: 1 ♂, 2 ♀♀ collected. **Loc. 23**: 10.03.2019: 1 ♀ collected. **Loc. 26**: 1.07.2018: 2 teneral ♀♀ collected.

E.S.: Not located: 12.14.2019: ♂ and a teneral ♂.

Observations. Occurs less frequently than *A. minima* and *A. pygmaea*, mostly at moist grassy places.

16. *Agriocnemis pygmaea* (Rambur, 1842)

O.K.: **Loc. 2:** 11.12.2019: 2 ♂♂ collected. **Loc. 23**: 10.03.2019: 1 ♂, 1 ♀ collected, several ♂♂ and copulae seen. **Loc. 26**: 3.11.2018: 1 ♂ collected.

E.S.: **Loc. 18**: 10.03.2019: 1 ♂. Not located: 7.03.2019: ♂.

Observations. Rather common in emerging fine grass, like *A. minima*. Curiously, while *A. pygmaea* was found in 4 localities and *A. minima* in 6 ones, there was no locality where both were found together. However we several time found them together in the below lower areas of Siem Reap Prvince.

17. *Argiocnemis rubescens rubeola* Selys, 1877

O.K.: **Loc. 12:** 11.03.2019: 1 ♂ collected. **Loc. 19**: 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 6**: 11.04.2018: ♂.

Observations. Rather a rare species.

Figure 38. A male of Archibasis viola **at the Siem Reap River upstream of the 2nd bridge (Loc. 12), 11.03.2019, O.K.**

18. Archibasis viola Lieftinck, 1949 (Fig. 38)

O.K.: **Loc. 11:** 17.06.2018: 1 ♂ collected; 4.11.2018: 1 ♂, 1 tandem collected, several ♂♂ seen; 30.11.2019: 1 ♂ seen. **Loc. 12:** 11.03.2019: 1 ♂ photo (Fig. 38). **Loc. 17**: 29.11.2019: 1 ♂ collected. **Loc. 19** (shady area): 10.03.2019: 1 ♂ collected, several ♂♂ seen; 29.11.2019: 1 ♂ collected.

E.S.: **Loc. 24:** 14.03.2020: ♂.

Observations. Always occurs in shade at small water courses in evergreen forest: at a tiny brook (Loc. 11), rarely at shady banks of the larger O'Dar (Siem Reap) River (Fig. 38) (Locs 12 and 19), and in swamped 'floating forest' of Thnal Mareh (Loc. 17).

19. *Ceriagrion cerinorubellum* (Brauer, 1865)

O.K.: **Loc. 13**: 11.03.2019: 1 ♂ seen. **Loc. 17**: 28.11.2019: 1 ♂, 1 ♀ seen, 29.11.2019: 2 ♂♂ seen. **Loc. 20:** 28.11.2019: several ♂♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen.

E.S.: **Loc. 16**: 27.10.2019: ♂, ♀. **Loc. 19**: 10.03.2019: 1 ♂ seen; 29.11.2019: 1 ♂ seen at the small pond. **Loc. 20:** 23.10.2019: ♂; 27.10.2019: ♂. **Loc. 25:** 27.04.2019: ♀. Not located: 7.03.2019: ♂ and tandem; **Loc 18**: 14.05.2019: ♂ and tandem; 10.03.2019: 1 ♂.

Observations. A conspicuous and more or less common species occurring at sunlit vegetation at small or medium streams, often on forked fern 'walls'.

20. *Ceriagrion indochinense* Asahina, 1967

O.K.: **Loc. 4** (at an adjacent grassy glade): 6.11.2018: 1 teneral ♂ photographed and collected.

Photo by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: May 2013: ♂

Observations. Found only twice and for some reason only at the Kbal Spean Rivulet, on the western plateau and at its E foot.

21. *Ceriagrion malaisei* Schmidt, 1964

O.K.: **Loc. 2**6: 1.07.2018: 1 mature ♂ collected.

Observations. Found only once at the lowland reach of the Siem Reap River in Banteay Srei village, at a small patch of Marsilea sp. at a shallow right bank.

22. Ceriagrion olivaceum Laidlaw, 1914

O.K.: **Loc. 7**: 23.02.2017: 1 ♂, 1 ♀ collected, 1 more ♂ seen. **Loc. 12:** 30.11.2019: 1 ♂ collected. **Loc. 13**: 11.03.2019: 1 ♀ collected.

E.S.: **Loc. 6**: 22.12.2018: ♂. **Loc. 12:** 13.12.2018: ♂. At Peung Tbal 1.5 km SW of Anlong Thom village (13.535 N, 104.154 E): 22.12.2018: ♂.

Observations. Another dry season species, met from November to March.

23. *Ischnura aurora* (Brauer, 1865) (Fig. 39)

E.S.: **Loc. 19**: 7.10.2019: ♂ (Fig. 39).

Remarks. A rare species recorded once (Fig. 39); also once recorded in the lowland in the same Siem Reap province at lake Tonle Sap (Kosterin 2020b).

Figure 39. A male of Ischnura aurora **at the O'Dar River near Anlung Thom village (Loc. 19), 7.10.2019, E.S.**

24. Ischnura senegalensis (Rambur, 1842)

E.S.: **Loc. 1**: 11.12.2019: several ♂♂, ♀♀ seen. **Loc. 20:** 23.10.2019: ♂;

Remarks. This is maybe the commonest elsewhere in the Oriental Ecoregion damselfly, but for some reason it appeared extremely rare in Phnom Kulen. Recorded only two times (one of which. at Loc. 1, at the foot rather than in the mountains).

25. *Mortonagrion aborense* Laidlaw, 1914

O.K.: **Loc. 11:** 30.11.2019: 1 ♀ collected.

Observations. A female was found hovering amidst bush vegetation in a small brook valley densely overgrown with evergreen forest, that is a typical habitat of the species.

Figure 40. A male of Paracercion calamorum dyeri **at the shallow S bank of the Tnal Dach Reservoir (Loc. 20), 29.12.2019, O.K.**

26. Paracercion calamorum dyeri Fraser, 1919 (Fig. 40)

O.K.: **Loc. 20:** 28-29.11.2019: many ♂♂ seen; 29.11.2019: 1 ♂ photo (Fig. 40).

Observations. Found only in the largest lentic habitat on the Phnom Kulen, the Tnal Dach Reservoir. Males perch on sparse vegetation floating on the water surface (Fig. 40).

27. *Pseudagrion australasiae* Selys, 1876

O.K.: **Loc. 1**: 11.12.2019: several ♂♂ seen, some captured and released. **Loc. 12:** 11.03.2019: 3 ♂♂ collected, many ♂♂ seen. **Loc. 16**: 28.11.2019: 4 ♂♂ collected, several more ♂♂ seen. **Loc. 17**: 28.11.2019: 1 ♂ released; 29.11.2019: 1 ♂ collected, at the small pond many ♂♂ seen. **Loc. 20:** 28-29.11.2019: 2 ♂♂ collected, many ♂♂ seen. **Loc. 25:** 2.12.2019: several ♂♂ seen. **Loc. 26**: 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 20:** 23.10.2019: ♂.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: 05.2013: ♂.

Observations. Common at lentic habitats but occurs at calm reaches at streams as well. The males of this species seem to be the most active fliers among congeners, they perch on floating vegetation without perch fidelity and also patrol the water surface by fast flying low above it.

28. *Pseudagrion pruinosum* (Burmeister, 1839)

O.K.: **Loc. 6**: 11.06.2018: several ♂♂ seen. **Loc. 7**: 11.06.2018: 2 ♂♂ collected, 1 ♂ photo, 1 tandem seen. **Loc. 10:** 12.06.2018: 1 ♂ seen. **Loc. 12:** 4.11.2018: 3 ♂♂, 1 ♀ collected, 1 more ♂ seen' 11.03.2019: several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: 1 ♂ collected; 29.11.2019: 1 ♂ photo. **Loc. 21:** 29.11.2019: 1 ♂ seen.

E.S.: **Loc. 6**: 3.12.2018: ♂. **Loc. 12:** 16.12.2018: ♂. **Loc. 1**9: 14.05.2019: ♂; 25.11.2019: ♂. Not located: 23.03.2014: ♂; 30.04.2015: ♂; 12.04.2019: ♂.

Observations. Inhabits streams and small rivers with slow to medium current flowing through evergreen forest; in Siem Reap Province not found at the lowland. This species is almost invariably found in places where the large-leaved plants from the tribe Colocasiae grow at banks (*Colocasia* or *Allocasia*, taro or elephant ear). Of course no direct ecological interactions is implied, both plants and damselflies just prefer the same habitats.

29. *Pseudagrion rubriceps* Selys, 1876

O.K.: **Loc. 1**: 11.12.2019: several ♂♂ seen. **Loc. 6**: 23.02.2017: 1 ♂ seen. **Loc. 12:** 11.03.2019: many ♂♂ seen; 30.11.2019: very many ♂♂ seen. **Loc. 19**: 29.11.2019: 1 ♂ seen. **Loc. 23**: 10.03.2019: 1 ♂ seen. **Loc. 25:** 2.12.2019: very many ♂♂ seen. **Loc. 26**: 3.11.2018: many ♂♂, several tandems seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 7**: 23.02.2017: ♂. **Loc. 1**9:10.03.2019: ♂ and copula; 25.11.2019: ♂♂. **Loc. 20:** 23.10.2019: ♂. **Loc. 22:** 25.11.2019: ♂. **Loc. 23**: 10.03.2019: ♂. Not located: 7.03.2019: ♂; 12.04.2019: ♂; 7.10.2019: ♂;

Observations. A common Oriental species which can be found even at lentic anthropogenic habitats. However, among 10 its known habitats in Phnom Kulen 9 are riverine, of which 6 were at the same Siem Reap River 'in the broad sense'. The males of this species keep to the grass at the banks and fly over the water surface among those of *P. williamsoni, P. australasiae* and *P. pruinosum*.

Figure 41. A tandem of Pseudagrion williamsoni **at the Siem Reap River at the bridge in Banteay Srey village (Loc. 26), 1.07.2018, O.K.**

30. *Pseudagrion williamsoni* Fraser, 1922 (Fig. 41)

O.K.: **Loc. 6**: 23.02.2017: 2 ♂♂ seen; **Loc. 12:** 4.11.2018: 1 ♂ collected, many ♂♂ seen; 11.03.2019: very many ♂♂ seen; 30.11.2019: very many ♂♂ seen. **Loc. 16**: 28.11.2019: many ♂♂ seen. **Loc. 17**: 28-30.11.2019: many ♂♂ seen. **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: several ♂♂ seen; 29.11.2019: many ♂♂ seen at the small pond. **Loc. 20:** 28-29.11.2019: very many ♂♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26**: 1.07.2018: 1 tandem photographed (Fig. 41) and collected, many ♂♂, ♀♀ and tandems seen; 3.11.2018: 2 ♂♂ seen; 2.12.2019: several ♂♂ seen.

E.S.: **Loc. 1**9: 25.11.2019: ♂. **Loc. 25:** 29.04.2019: ♀. Not located: 7.12.2018: ♂; 12.04.2019: ♂.

Observations. One of the most common damselfly at sunny places with slow or moderate current at small and medium rivers. Nevertheless, it was found surprisingly numerous at the grassy banks of the large Tnal Dach Reservoir (Loc. 20), which is drained by a small river but still has a still water.

Platycnemididae

31. *Copera marginipes* (Rambur, 1842)

O.K.: **Loc. 4**: 6.11.2018: 1 ♂ collected. **Loc. 5**: 6.06.2018: many ♂♂, ♀♀ seen. **Loc. 6**: 23.02.2017: 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 7**: 23.02.2017: many ♂♂, ♀♀ seen. **Loc. 9**: 4.11.2018: ♂ seen. **Loc. 11:** 17.06.2018: 1 ♀ collected; 30.11.2019: several ♂♂ seen. **Loc. 12:** 30.11.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: 1 ♂ collected, several ♂♂ seen; 28.11.2019: 1 ♂ collected, several ♂♂, ♀♀ seen.

E.S.: **Loc. 6**: 11.04.2018: ♂; 19.04.2018: immature ♂; 4.11.2018: ♂, ♀. **Loc. 10:** 11.04.2018: ♂♂; immature ♀; 4.11.2018: ♂; 3.12.2018: ♂. **Loc. 12:** 13.12.2018: ♂, ♀; 14.12.2018: ♂, ♀, copula; 22.12.2018: ♀. **Loc. 19**: 10.03.2019: ♂; 25.11.2019: ♂: **Loc. 20:** 23.10.2019: tandem; **Loc. 22:** 25.11.2019: tandem. **Loc. 25:** 27.11.2019: ♂. Not located: 20.03.2017: ♂; 27.04.2017: ♂; 4.12.2018: ♂.

Observations. Very common at sunny places at streams and rivers on the plateaux but only once found at the Siem Reap River in the lowland below.

32. *Copera vittata* (Selys, 1863)

O.K.: **Loc. 3**: 14.06.2018: 1 teneral ♂ collected. **Loc. 4**: 6.11.2018: very many ♂♂, several tandems seen. **Loc. 7**: 23.02.2017: 1 ♂, 1 ♀ collected, many ♂♂, ♀♀ seen. **Loc. 11:** 4.11.2018: many ♂♂, ♀♀, tandems seen; 30.11.2019: 2 ♂♂ collected, several ♂♂, 1 tandem seen. **Loc. 12:** 4.11.2018: 1 ♂ collected. **Loc. 17**: 28.11.2019: 1 ♀ collected; 29.11.2019: 1 ♂ collected, 1 ♂ seen. **Loc. 19**: 29.11.2019: 1 ♂ seen.

E.S.: **Loc. 6**: 3.12.2018: tandem.

Observations. Prefers shaded pools with a lot of litter, avoids stream banks.

33. *Onychargia atrocyana* Selys, 1865 (Fig. 42)

O.K.: **Loc. 20:** 28.11.2019: 1 ♂ collected, 1 more ♂ seen.

E.S.: **Loc. 12** (at a small brook, the left tributary of the main river): 14.05.2019: ♂; 16.06.2019: ♂. **Loc. 16**: 28.07.2019: ♂ (Fig. 42a); 7.11.2019: ♂; 14.03.2020**:** ♂. **Loc. 20:**

Figure 42. Males of Onychargia atrocyana **at the Srae Tbong River (Loc.16), 28.07.2019 (a) and at the dam of the Tnal Dach Reservoir (Loc. 20), 7.11.2019 (b), E.S.**

4.05.2019: ♂; 6.06.2019: ♂; 12.06.2019: ♂; 7.10.2019: ♂; 23.10.2019: ♂; 27.10.2019: ♂; 7.11.2019: ♂ (Fig. 42b).

Observations. Can be found (Fig. 42a) at margin of the trees growing at the dam of the Dnal Dach Reservoir (Loc. 20) seemingly at any season. The reservoir bank at the dam, steep but densely overgrown with grass and herbs, seems to provide the most suitable habitat of the species. Only two records elsewhere.

34. *Onychargia priydak* Kosterin, 2015 (Fig. 43)

O.K.: **Loc. 2:** 11.12.2019: 1 ♂ photo (Fig. 43).

Observations. The only male (Fig. 43) was found at the foot of the south-western spur of the western plateau in rather a specific habitat: in a tiny glade in bush thickets several metres apart from a brook hidden under winding plants, in a gentle bushy valley, the slope of which were converted into cassava fields. For some reason that male was so calm that remained still even when slightly touched and it was necessary to push it to make it to get into the air and to fly for several centimetres.

Figure 43. A male of Onychargia priydak **in a small glade in buch thickets near a brook at the western low spur of the western Phnom Kulen plateau (Loc. 2), 11.12.2019, O.K.**

35. *Prodasineura autumnalis* (Fraser, 1922) (Figs 44-45)

O.K.: **Loc. 4**: 14.06.2018: 1 ♂ collected; 6.11.2018: 1 ♂ collected. **Loc. 5**: 6.11.2018: 1 ♂ seen. **Loc. 8**: 12.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ collected; 30.06.2018: several ♂♂ seen. **Loc. 12:** 30.11.2019: several ♂♂ seen. **Loc. 19**: 29.11.2019: several ♂♂ seen. **Loc. 25:** 2.12.2019: many ♂♂ and tandems seen. **Loc. 26**: 14.06.2018: 3 ♂♂ collected (Fig. 44); 3.11.2018: 1 ♂ collected; 1.07.2018: very many ♂♂, ♀♀ seen; 2.11.2018: very many ♂♂ and tandems seen.

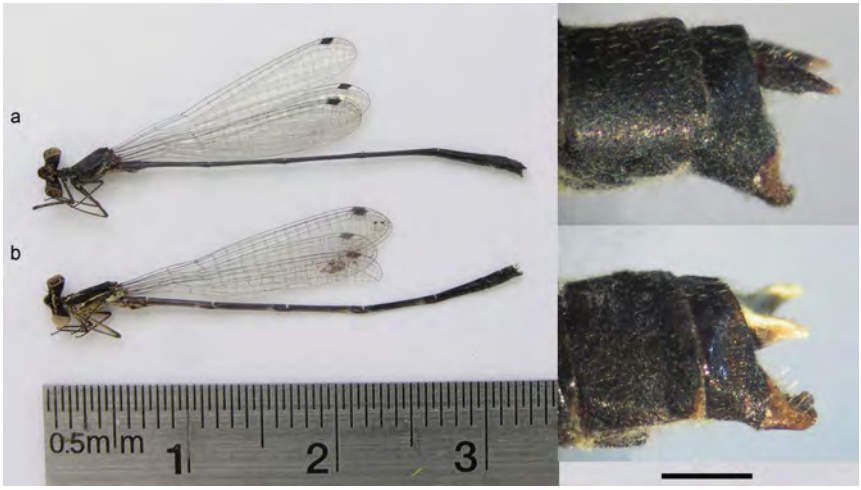

Figure 44. A mature (a) and immature (b) males of Prodasineura autumnalis **from the Siem Reap River at the bridge in Banteay Srei village (Loc. 26), 14.06.2018. Scale bar 0.5 mm. O.K. Note mostly pale dorsolateral surfaces of the cerci in the young male. The seemingly different shape of the cerci in the two males shown resulted the position of the left cercus in the mature one (a), slightly turned along its axes so that its basoventral projections is hidden.**

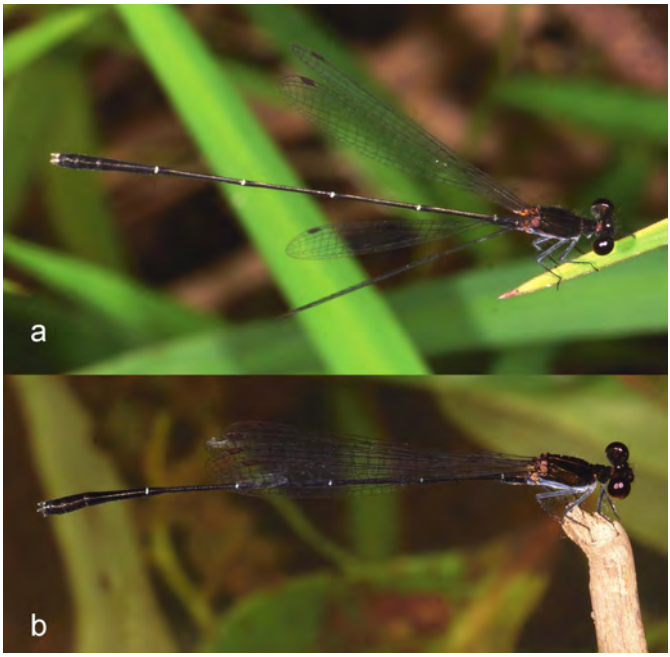

Figure 45. Mature males of Prodasineura autumnalis **with pale above (a) and entirely dark (b) cerci photographed on 30.05.2019 from the Siem Reap River at the first bridge after its leaving the mountains (Loc. 25), E.S.**

E.S.: **Loc. 10:** 5.11.2019: ♂. **Loc. 1**9: 5.11.2019: ♂, copula; 25.11.2019: ♂. **Loc. 25:** 29.04.2019: ♂; 15.05.2019: ♂; 30.05.2019: 2 ♂♂, with white above (Fig. 45a) and dark (Fig. 45b) cerci, tandems; 3.11.2019: immature ♂; 27.11.2019: ♂, 2 ovipositing tandems.

Observations. Common over the surface of small (Kbal Spean, Srae Tbong) or, mostly, medium (namely Siem Reap, all along its course) rivers.

Remarks. In *Prodasineura* males, the coloration of the last abdominal segments and appendages are as a rule species-specific and provide useful identification cues. In this respect the issue of the cercus colour in males of *P. autumnalis* can be confusing. In the Phnom Kulen collection, the mature males, with the thorax black with only a dull yellowish stripe on the metepimeron and a yellowish area on the poststernum left, have the cerci characteristically brownish-black with paler extreme bases and tips (Figs 44a, 45a), as is common for mature males of this species. However, in a young male of 14.06.2018 from Loc.26 (Fig. 44b) collected along with two mature males (Fig. 44a), which still retained the full pattern of cream-white stripes, namely the antehumeral stripes at the mesepisternum and broad lateral stripes along the mesothoracic suture and on the metepimeron, the dorso-lateral surfaces of the cerci are mostly clear creamy-white while their ventro-adaxial surfaces are mostly brownish (Fig. 44b). This seemingly an ageing/maturation-related change is nevertheless striking. Moreover, E.S. managed to photograph (at the same river part but somewhat upstreams, Loc. 25) a mature male, with the pale thoracic stripes already disappeared and the lower part of the synthorax pruinosed, in which the cerci were still pale above (Fig. 44a, compare a similar male from the same place and date with dark cerci in Fig. 44b). The issue of the coloration of the cerci in *P. autumnalis* deserves further attention.

36. *Prodasineura coerulescens* (Fraser, 1932) (Figs 46)

O.K.: ?**Loc. 7**: 23.02.2017: 1 teneral ♀ collected, identification tentative. **Loc. 25:** 2.12.2019: 1 ♂ collected. **Loc. 26**: 12.06.2018: 1 ♂ photo, several ♂♂, ♀♀ seen; 14.06.2018: 3 ♂♂, 2 ♀♀ collected, many ♂♂ seen; 1.07.2018: 1 ♀ collected, several ♂♂ photo (Fig. 46c), many ♂♂, ♀♀ seen; 3.11.2018: 1 ♂ collected, several ♂♂ seen.

E.S.: **Loc. 25:** 29.04.2019: ♂; 15.05.2019: tandem (Fig. 46a); 30.05.2019: ♂, ♀ and a tandem; 27.11.2019: tandem. **Loc. 26**: 30.05.2019: ♀.

Observations. These damselflies are abundant at the Siem Reap River where it already left the mountains but still is rather fast and clear, at Locs 25 and 26 (the latter in the famous Banteay Srei village). There they fly together with *P. autumnalis* but rather outnumber them. The males and tandems spend a lot of time hovering at the same place over the surface of fast, sunny river reaches and are very conspicuous (Fig. 46a,c). At the same time, unlike *P. autumnalis*, *P. coerulescens* seems to be confined to that river section near foothills and hardly expands upstream or downstream of it. There are only two observations by E.S. downstream of Banteay Srei (Loc. 26), 12.5 km SSW of it, where the river is already broad, deep and very calm: 13.490 N, 103.921 E; 13.09.2018 (♀); the same place, 17.09.2018 (♂; Fig. 46b) (at the same time *P. autumnalis* is still rather common at that point round the year). In the mountains, only one teneral female was collected at the same

river at the carvings but its identification is based on the horns of prothorax directed forward and is not so reliable.

Figure 46. A tandem (a) and males (b-c) of Prodasineura coerulescens **over the Siem Reap River after its leaving the mountains: a – Loc. 25, 15.05. 2019, E.S.; b - 13.490 N, 103. 921 E, 17.09. 2018, E.S.; c – Loc. 26, 1.07. 2018, O.K.**

37. *Prodasineura verticalis* sensu Asahina, 1983 nec Selys (1860)

O.K.: **Loc. 3**: 14.06.2018: 1 teneral ♂ collected. **Loc. 4**: 14.06.2018: 2 ♂♂, 1 tandem seen; 6.11.2018: 1 ♂, 1 tandem seen. **Loc. 7**: 11.06.2018: 5 ♂♂, 3 ♀♀ collected, 1 ♂, 1 ♀ photo, many ♂♂, ♀♀ seen. **Loc. 8**: 12.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ seen. **Loc. 9**: 17.06.2018: 3 ♂♂, 3 ♀♀ collected in tandems, several ♂♂, ♀♀ seen; 30.06.2018: several seen. **Loc. 10:** 12.06.2018: several ♂♂ seen; **Loc. 11:** 12.06.2018: several ♂♂, ♀♀ seen; 4.11.2018: 1 ♀ seen. **Loc. 12:** 4.11.2018: 2 ♂♂ seen; 11.03.2019: several ♂♂, ♀♀ seen; 30.11.2019: 1 ♂ seen. **Loc. 13**: 30.06.2018: several seen; 11.03.2019: 1 tandem seen. **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: 1 ♂ collected, several ♂♂, ♀♀ seen; 29.11.2019: 1 ♂ seen.

E.S.: ♂. **Loc. 12:** 14.05.2019: tandem; 16.07.2019: ♀ (at a small brook, the left tributary of the main river). **Loc. 19**: 14.05.2019: ♂; 20.07.2019: ♂; 25.11.2019: ♀. **Loc. 14:** 3.12.2018: teneral ♂. **Loc. 22:** 25.11.2019: ♀. **Loc. 24:** 13.03.2020: ♂. Not located: 28.06.2015: ♂; 25.07.2018: ♂; 12.04.2019: ♂; 24.04.2019: ♂, tandem.

Photo by Phann Sithan in Facebook group 'Natural Cambodia': **Loc. 4**: 6.08;2014: ♂.

Remarks. Since publication of the Thai Odonata Atlas by Hämäläinen & Pinratana (1999) this well known species is recognised as yet undescribed. Hopefully it will be eventually described in near future.

Observations. Common at rivers or brook, preferring the latter, but, unlike the two previous species, keep to shady places where are mostly seen hovering in gaps among vegetation at the height of 1-1.5 m. In such shady conditions, the saturated orange thoracic stripes of hovering males are very conspicuous, unlike the rest of the body. A tandem ovipositing onto slime algae in a tiny stream between stones was observed at Loc. 7.

38. *Pseudocopera ciliata* (Selys, 1863)

O.K.: **Loc. 12:** 11.03.2019: 1 ♂, 1 ♀ seen; 30.11.2019: many seen. **Loc. 17**: 28-30.11.2019: very many seen. **Loc. 19**: 10.03.2019: 1 ♂ seen. **Loc. 20:** 28-29.11.2019: very many seen (mostly at a shallow grassy bay). **Loc. 21:** 29.11.2019: several ♂♂, ♀♀ seen. **Loc. 26**: 14.06.2018: 1 ♂ collected; 1.07.2018: many ♂♂, ♀♀ seen; 6.11.2018: 1 ♂ collected, many ♂♂ seen.

E.S.: **Loc. 19**: 14.05.2019: ♂; 5.11.2019: ♂. **Loc. 20:** 6.06.2019: ♂. 0.07.2019: ♀; 7.10.2019: ♂♂, ♀♀; 23.10.2019: ♂, ♀; 27.10.2019: ♂, ♀; 5.11.2019: ♂, ♀.

Observations. Common. Keeps to fine low Poaceae grass at shallow water of streams or lakes/ponds with clear water. On Phnom Kulen finds best habitats at the river branches flowing through grassy mats at Srae Tmar Truonh (Loc. 21), at shallow grassy bays of Tnal Dach Reservoir (Loc. 20) and at the shallower banks of the Siem Reap River in Banteay Srei (Loc. 26).

Aeshnidae

39. *Gynacantha subinterrupta* Rambur, 1842 (Figs 47)

O.K.: **Loc. 11:** 10.03.2019: 1 ♂ photo, maybe 1 more seen. **Loc. 17**: 29.11.2019: 1 ♀ photographed (Figs 47) and collected.

Figure 47. A female of Gynacantha subinterrupta **in evergreen forest in the Rong Chen Archaeological Protected Area (Fig. 10) near Tnal Mareh terrain (Loc. 17). 29.11.2019, O.K.**

Observations. Surprisingly there were only two findings of this species, common elsewhere in forested areas of Cambodia. On March 10, 2019, at the end of dry season, one or two males were startled from shaded earthy bluffs, with hanging roots, at two adjacent dried out pools of the temporary forest brook of Loc. 11 downstream of the road. This male (or these males) obviously returned to that place and were startled again. Just downstream from these former pools, another male flew at deep round holes in the sandstone brook bed, and even penetrated inside for a while. These pools, where dark water still left (Fig. 20, left), could serve a good larval habitat for this species, so that male was most probably searching for ovipositing females. However they are probably not so good a habitat in the rainy season when the brook is flowing (Fig. 20, right). Maybe for this reason these dragonflies were not seen there at other visits. Pools at the Tnal Mareh swamped forest (Loc. 17), near which a female was found in evergreen forest (Figs 47), could serve for breeding as well.

40. *Tetracanthagyna waterhousei* McLachlan, 1898

O.K.: **Loc. 11:** 12.06.2018: 1 ♀ collected.

Observations. The only female met was startled from a big half-open pool at the brook, bordered on one side with a forked fern thicket.

Gomphidae

41. *Euthygomphus yunnanensis* (Zhou et Wu, 1992)

O.K.: **Loc. 26**: 14.06.2018: 1 ♂ collected.

Remarks. For the correct naming of this species, formerly known as *Merogomphus parvus* sensu Asahina, 1986 nec Krüger, 1899 see Kosterin (2016a). The occiput colour is variable in both sexes of this species (Ibid.); in the male from Loc. 26 it is black.

Observations. The only male found was startled from a bamboo branch hanging over the Siem Reap River just upstream of the bridge in Banteay Srei and sat on a tree branch hanging nearby. Remarkably this happened almost in twilight, at 5:50 p.m. Earlier O.K. observed this species only in daytime at herbs and bushes growing on the bank rather than hanging over the water (Kosterin 2011; 2015a; 2016a,b; 2017).

42. *Burmagomphus* sp. cf. *williamsoni* Förster, 1914 (Fig. 48)

O.K.: **Loc. 8**: 12.06.2018: 1 ♂ collected and missed; 17.06.2018: 1 ♂, 1 ♀ collected; 1 ♂, 1 ♀ photo (Fig. 48a-b); 30.06.2018: 2 ♂♂ collected, 1 more ♂ seen.

E.S.: **Loc. 19**: 15.05.2019: ♂; **Loc. 25:** 15.05.2019: ♂ (Fig. 48c).

Remarks. The following male characters are shared with *B. williamsoni* as described and illustrated by Lieftinck (1953; 1964): the antehumeral and dorsal stripes fused into a broad kinked stripe, the posterior hamulus very broad with an anteriorly directed hook and without additional denticles or long hairs, the epiproct arms in line with the cerci when viewed above, the tooth of the cercus occupying a subapical position. The following male character differ from B. *williamsoni*: the antehumeral pale stripe is narrowly separated from that on the inframesepisternum with black (not so in female); the subapical cercal tooth very prominent, forming almost a right angle in dorsal view and well seen in lateral view; the paraproct arms as long as (rather than shorter than) the cerci and with their inner margins distinctly convex, as in *Burmagomphus vermicularis* (Martin, 1904) (Do 2011: figs 2g-h, 3d), but the incision between them is not U-shaped as in both mentioned species but trapezoid-shaped, with a straight central section. S9 has no dorsoapical tooth (a character variable in some other species of the genus). The female occiput has a prominent yellow conical projection, as in *B. williamsoni* but, unlike that species (Lieftinck 1953: fig. 40; 1964: fig. 20-22), misses the pair of bi- or tridental tubercles at its sides (the occiput of *B. vermicularis* is simple, straight, see Lieftinck 1953: fig. 41). The teneral *Burmagomphus* female collected at Pramoll Phdom village in Preah Vihear Province (Kosterin 2020a) is similar. The above mentioned characters nearly justify a separate species but further study is necessary.

Observations. Found in May-June. Most sightings were made at a big and deep river broadening under the Kulen Waterfall (Loc. 8). There these dragonflies appeared at around 9:30 a.m., rest on big boulders by the water (but far beyond the reach of the waterfall spray) (Fig 48a-b), rarely on shrubs growing on rocks, or fly low over the water surface, sometimes chasing matches. Two other localities were the same river upstreams (Loc. 19) and downstreams, already after its having left the mountains (Loc. 25) (Fig. 48c).

Figure 48. Female (a) and males (b-c) of Burmagomphus **sp. cf.** williamsoni**: a-b – at the Phnom Kulen waterfall (Loc. 8), 17.06.2018, O.K.; c – at the Siem Reap River at the first bridge after its leaving the mountains (Loc. 25), 15.05.2019, E.S.**

43. *Gomphidia* sp. ♂ (Fig. 49)

O.K.: **Loc. 4**: 14.06.2018: 1 ♂ seen (identification tentative). **Loc. 9**: 30.06.2018: 1 ♂ seen (identification tentative). **Loc. 10:** 30.06.2018: 1 ♂ collected. **Loc. 11:** 17.06.2018: 1 ♂ seen; 30.06.2018: 1 ♂ collected, 1 more ♂ photo (Fig. 49).

Remarks. The same species as reported from Thma Bang environs of Kog Kong Province (but not that from Mondulkiri Province in the same paper) as *Gomphidia kruegeri*, nec Martin, 1904. (Kosterin 2016b). They showed a combination of maculation characters of the taxa *kruegeri* s. str. and *fukiensis* Chao, 1955 (the latter considered by Kosterin (2016b) as subspecies of *G. kruegeri*), but had a black spot in the centre of the labrum reported for neither of those two species. However, *G. fukien-*

Figure 49. Males of Gomphidia **sp. (above) and** Zygonyx iris malayana **(below) perching on the same stick at the lowermost reaches of the forest brook of Loc. 11, 30.06.2018, O.K.**

sis has been shown to be bona species (Zhang 2019), while the Cambodian specimens most probably represent a different species to be described elsewhere.

Observations. Found only in June, in the lowest reaches of a brook (Loc. 11) and the Siem Reap/Prey Thom River at their junction point (Loc. 10). The dragonflies observed downstream of the Kulen Waterfall on the same river (Loc. 9) and at the Kbal Spean River on the western plateau (Loc. 4) had the same size, habitus and behaviour but were not caught. At both Loc. 4 (the brook) and Loc. 11 (Kbal

Spean River), males perched on dry sticks at long calm reaches with a sandy (in the former case) or litter (in the latter case) bottom, ranged along the reach and were cautious. Curiously, at loc. 11 the same dry stick was occupied by a male on 17.06.2018 and 30.06.2018. In the first case when the male was startled from that stick it rose to the tree crowns and sat on a dry branch at ca 4 m above the ground, then disappeared. In the second case the male tried to chase out a male of *Zygonyx iris malayana* but at last they perched on the same stick very closely to each other (Fig. 49). At the larger river of Loc. 10 the male landed on a green branch hanging lower above the water.

44. *Ictinogomphus decoratus melaenops* (Selys, 1858)

O.K.: **Loc. 19**: 10.03.2019: 1 ♂, 1 ♀ seen. **Loc. 20:** 29.11.2019: 1 ♂ photo, several ♂♂ seen. **Loc. 23**: 10.03.2019: 1 ♂ seen. **Loc. 26**: 1.06.2018: 1 ♂ photo, quite many ♂♂ seen; 3.11.2018: 2 ♂♂ seen.

E.S.: **Loc. 1**9: 14.05.2019: ♂. **Loc. 20:** 6.06.2019: ♂. Not located: 12.04.2019: ♂; 24.04.2019: ♂♂.

Observations. A lentic non-seasonal species, found in Phnom Kulen at the big water reserve Tnal Dach (Loc., 20) which looked the most fit habitat, on broad and slow pools at a brook (Loc. 23) and the main river of the eastern plateau (Locs 19, 26), including downstream of it at Banteay Srei (Loc. 26). Males perch on sticks and range broadly over the water surface, being rather incautious.

45. *Macrogomphus kerri* Fraser, 1922

O.K.: **Loc. 8** (shady reach just below the waterfall): 12.06.2018: 1 ♂ collected. **Loc. 11:** 17.06.2018: 1 ♂ collected. **Loc. 26**: 1.07.2018: 2 ♂♂ photo.

E.S.: **Loc. 26**: 27.04.2019: ♂.

Observations. Observed in April-July. On the plateau both males were met while very fast ranging at the height of 1-2 m in forest shade, along the forked fern thickets in the lowermost reaches of the brook tributary of the same river (Loc. 11) or along the bank and damp rocks just below the Kulen Waterfall (Loc. 8). On the same Siem Reap River just downstream of the bridge in Banteay Srei (Loc. 26) O.K. unexpectedly noticed a male ranging over a fast shady reach which then rose and sat on a dry branch in a tree crown ca 4 m above the river, very closely to another male of that species which appeared already sitting there.

46. *Microgomphus alani* Kosterin, 2016

O.K.: **Loc. 6**: 11.06.2018: 1 ♀ collected. **Loc. 9**: 17.06.2018: 1 ♂ collected. **Loc. 11:** 30.06.20**1:** 1 ♀ collected.

Remarks. For morphological and ecological details of this species, including its above enumerated Phnom Kulen findings, see Kosterin (2019b).

Observations. Found at the banks of the main river (locs 6, 9) and its tributary brook (loc. 11) half-shaded by evergreen forest.

47. *Paragomphus capricornis* (Förster, 1914) (Fig. 50)

O.K.: **Loc. 12:** 4.11.2018: 1 ♀ photo (Fig. 50). **Loc. 26**: 3.11.2018: 1 ♂, 1 ♀ collected.

E.S.: **Loc. 25:** 27.11.2019: ♂.

Observations. For some reason observed in November only, two sightings below the plateau versus one on it. In the first case both sexes perched on bushes by a relatively high river bank, in the second case a female sat on a dry stick (Fig. 50) on a dry glade separated from a river by a tree strip.

Figure 50. A female of Paragomphus capricornis **perching on a stick on a dry glade by the Siem Reap River upstream of the second bridge (Loc. 12), 4.11.2018, O.K.**

Synthemistidae

48. *Idionyx thailandica* Hämäläinen, 1985

O.K.: **Loc. 8**: 12.06.2018: 1 ♂, 8 ♀♀ collected, dozens of ♀♀ seen. **Loc. 11:** 12.06.2018: 3 ♀♀ collected, 1 ♀ released; 17.06.2018: 4 ♀♀ released.

Remarks. Perhaps the same species as *Idionyx victor* Hämäläinen, 1991, the claimed diagnostic differences being variable and not convincing (Karube 2011). The current (mal)practice is a country based identification: specimens from China and Vietnam are traditionally identified as *I. victor* while those from Thailand and Cambodia as *I. thailandica*.

For some reason in some populations females are much more common than males: at least in Ratanakiri Province (Kosterin 2014) and Phnom Kulen (this paper). Among 17 individuals checked in hand in Phnom Kulen, only one male was found.

Observations. In June found common/numerous in two specific places, active either in shade at daytime (Loc. 11) or in dusk (Loc. 8).

At the lowermost brook of Loc. 11, females (at least three on 12.06.2018 and two on 17.06.2018) oviposited at daytime but in deep shade while fast flying immediately above the water seeping between the big round holes in sandstone filled with water (Fig. 20, left). Another female was caught on 12.06.2018 while fast flying (among males of *Macromidia rapida*, see below) very low above the water seeping over a concrete plate from the pipes through which the brook crosses the road. On 17.06.2018, two females fluttered over the road crossing this brook when the sun was hidden by an approaching thunderstorm cloud. At ca 5:30 p.m. of 12.06.2018, O.K. witnessed as numerous individuals of *I. thailandica* appeared below the Kulen Waterfall (Loc. 8), starting to flutter low and erratically near a narrow bay (from 2-3 m apart from water to the water edge) of the pool below the waterfall – not less than 20 in view at once – and many also above rocks on the banks (here again together with males of *M. rapida*). Six of them checked in hand were females. Few individuals also flew above a trading 'street' above the waterfall; of the two checked one appeared to be a male, the only one obtained from Phnom Kulen.

There were also two uncertain sightings on 14.06.2018 of females probably of this species ovipositing in shaded shallow bays of the Kbal Spean River upstream of the carvings (Loc. 4).

49. *Macromidia rapida* Martin, 1907

O.K.: **Loc. 4**: 14.06.2018: 1 ♂ collected, 1 more ♂ seen. **Loc. 8**: 12.06.2018: very many ♂♂ seen, 1 ♂ collected. **Loc. 10:** 17.06.2018: 1 ♂ released. **Loc. 11:** 12.06.2018: 6 ♂♂ collected, 1 ♂ released; 17.06.2018: 1 ♂ released; 30.06.2018: 1 ♂ released, 1 ♂ seen.

Observations. Found in the same places and as a rule together with *I. thailandicus* from the same family (the latter not confirmed from Loc. 4) in either shade or dusk, although on 30.06.2018 only *M. rapida* was observed. But while *M. thailandicus* was represented mostly by females, only males of *M. rapida* were met.

On 12.06.2018 O.K. managed to catch one by one for a very short time 6 males of *M. rapida* (along with a female of *I. thailandica*) ranging very low above the aforementioned water seeping over concrete basement from the pipes through which the brook of Loc. 11 crosses the road; one more male was caught over the shady lowermost brook reach with round holes (Fig. 20, left), also along with females of *I. thailandica*. In the evening of the same day, at ca 5:30 p.m., males of *M. rapida* were found ranging over small pools between boulders and rocks at the pool below the Kulen Waterfall (Loc. 8). They were flying very low and rather slowly as compared to females of *I. thailandica* flying above them, erratically, faster and at a greater height. On both 17.06.2018 and 30.08.2018 only one male was observed flying over the water seeping from that pipe bridge of Loc. 11. Also on 17.06.2018 a male ranged over the shady bank of the main river (Loc. 10) near the brook mouth, and on 30.08.2018 a male was caught at the brook reach with the round holes, which ranged over the height of 1 m (rather than very low over the water as usual). At the Kbal Spean River (Loc. 4), two males were seen while elusively ranging over shady shallow reaches as well.

Macromiidae

50. *Epophthalmia frontalis* Selys, 1871

O.K.: **Loc. 16**: 28.11.2019: 1 ♂, 1 ovipositing ♀ seen; **Loc. 20** (near the outlet): 28.11.2019: 1 ♂ seen. **Loc. 26**: 1.07.2018: 1 ind. seen.

Remarks. Sightings only, identification tentative.

Observations. At loc. 16 examined between 3 and 3:30 p.m., a female appeared each time soon after the sun appeared from clouds and several times flew along the considerable river. Twice it started ovipositing at the border of a shallow place with emerging vegetation and a deep place, flying fast to and fro and hitting the surface with its abdomen with such a strength that spray reached O.K.'s face. Two times a male was also seen flying by for a little while. The two other sightings were of a dragonfly ranging quite high and fast along the Siem Reap River, on the plateau where it left the Tnal Dach Reservoir (Loc. 20) and on the lowland at Banteay Srei (Loc. 26).

51. *Macromia aculeata* Fraser, 1927 (Fig. 51)

O.K.: **Loc. 26**: 1.07.2018: 1 ♂ collected (Fig. 51).

Remarks. For clarification of the identity and distribution of this species see Kosterin (2015b).

Observations. On a sunny midday at a half-shaded fast reach the Siem Reap River downstream of the bridge in Banteay Srey, a male (Fig. 51) floated spread upside down but still alive on the river surface. Most probably its ruined position resulted from an attack of a male of *Onychothemis testacea*, several of which patrolled the water surface.

52. *Macromia callisto* Laidlaw, 1922 (Fig. 52)

O.K.: **Loc. 11:** 17.06.2018: 1 ♀ collected (Fig. 52).

Remarks. Illustrations in Muraki (2014) were helpful for identification of this female, which is small (hind wing 33 mm, abdomen 38 mm, total length 51 mm) and has a broad yellow stripe across the frons, S2 broadly yellow atreriorly, S3-S5 with very small yellow spots, S7 with a yellow ring and S8 with traces of yellow spot at base (Fig. 52).

Observations. Captured in flight over a sandy open reach not far from the mouth (downstream from the road) of the Loc. 11 brook.

53. *Macromia cupricincta* Fraser, 1924 (Fig. 53)

O.K.: **Loc. 12:** 11.03.2019: 1 ♂ collected (Fig. 53).

Observations. A male ranged fast and low above the surface along a long, relatively deep but still fast, sunny reach of the main river of the eastern plateau.

Libellulidae

54. A*ethriamanta brevipennis* (Rambur, 1842)

O.K.: **Loc. 7**: 11.06.2018: 1 ♀ collected.

E.S.: **Loc. 26**: 30.05.2019: ♀.

Observations. This species, quite common at lowland ponds of Siem Reap Province, was only once found on the eastern plateau: a female perched ~2 m

Figure 51. A male of Macromia aculeata collected from the Siem Reap River surface downstream of the bridge in Banteay Srei village (Loc. 26, 1.07.2018, O.K.

above the ground on a long branch of a dead bush in a small glade separated by trees from the 1000 Linga (Siem Reap) River at carvings. No pond nearby, so this finding was unexpected and strange.

55. *Aethriamanta gracilis* (Brauer, 1878) (Fig. 54)

E.S.: **Loc. 20:** 6.06.2019: copula (Fig. 54).

Observations. Found only at the Tnal Dach Reservoir, the overgrown banks of which is a habitat very suitable for the species, which for some reason has not been found in the lowlands of Siem Reap Province.

Figure 52. A female of Macromia callisto **collected at the forest brook of Loc. 11, 17.06.2018, O.K.**

Figure 53. A male of Macromia cupricincta **collected at the Siem Reap River upstream of the 2nd bridge (Loc. 12). 17.06.2018, O.K.**

Figure 54. A copula of Aethriamanta gracilis **at the Tnal Dach Reservoir (Loc. 20). 6.06.2019, E.S.**

56. *Acisoma panorpoides* Rambur, 1842

O.K.: **Loc. 12:** 11.03.2019: several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 20:** 28-29.11.2019: very many seen. **Loc. 23**: 10.03.2019: many ♂♂ seen.

E.S.: **Loc. 20:** 6.06.2019: ♂; 5.11.2019: ♀. Not located: 7.03.2019: ♀; 24.04.2019: ♂, ♀.

Observations. Generally a common species but rather uncommon in Phnom Kulen. Occurs at herbs and grass emerging from water. Prefers lentic habitats (as Loc. 20) but occurs also at slow river reaches (Locs 12, 23).

57. *Brachydiplax chalybea chalybea* Brauer, 1868

O.K.: **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: several ♂♂ seen. **Loc. 20:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ photo, many ♂♂ seen.

E.S.: **Loc. 19**: 14.05.2019: ♂.

Observations. A lentic species not so common in Phnom Kulen. It however is thriving at the shallow N bank of Tnal Dach Reservoir overgrown with tall *Cyperus* sp.

58. *Brachydiplax farinosa* (Krüger, 1899)

O.K.: **Loc. 7** (a small pool on rocks): 12.06.2018: 1 ♂ collected, 1 more ♂ seen. **Loc. 20:** 29.11.2019 (among trees on the dam): 1 ♂ photo.

E.S.: **Loc. 7** (the same small pool on rocks): 18.05.2018: ♂; **Loc. 20:** 7.10.2019: ♂; 7.11.2019: ♂.

Photo by Timo Hartmann in Facebook group 'Natural Cambodia': Loc. 4: 21.09.2008: ♂.

Observations. The species prefers small overgrown ponds, so it is invariably found at a tiny but deep pool with *Nymphaea* on sandstone rocks at the linga carvings on the Siem Reap River (Loc. 7). Solitary males were also met at the Tnal Dach Reservoir (Loc. 20), e.g. a male perching on bushes in small sunlit spots under trees growing on the dam (29.11.2019).

59. *Brachydiplax sobrina* (Rambur, 1842)

O.K.: **Loc. 20:** 29.11.2019: 1 ♂ collected.

E.S.: Not located: 28.07.2018: ♂.

Remarks. The species is characterised as having 7 forewing antenodals (Asahina 1988), however the specimen collected has 6 ones on the left forewing and 7 in the right forewing.

Observations. A male was collected at the margin of grove near the dam of Thal Dach Reservoir.

Figure 55. Males of Brachygonia oculata**: a – in the Tnal Mareh floating forest (Fig. 7, Loc. 17), 28.11.2019, O.K., b – at a cold spring (Fig. 16) of the Siem Reap River right bank upstream of the carvings (Loc. 6), 24.07.2015, E.S.; c – in the floating forest at Loc. 17, 27.10.2019, E.S.**

60. *Brachygonia oculata* (Brauer, 1878) (Fig. 55)

O.K.: **Loc. 17**: 28-30.11.2019: very many ♂♂, many ♀♀ seen; 28.11.2019: 1 ♂ photo (Fig. 55a); 29.11.2019: 2 ♀♀ collected, 1 ♀ photo; 30.11.2019: 2 ♂♂ collected:
E.S.: **Loc. 6** (at a cold spring): 24.07.2015 (Fig. 55b): ♂; 6.10.2015: ♂; **Loc. 16**: 27.10.2019: ♂ (Fig. 55c).

Observations. A species usually confined to shady swampy forests (often behind mangroves). There is no surprise that it occurs plentifully in the 'floating forest' of Tnal Mareh (Fig. 55a) (Loc. 17, Fig. 7) and a similar habitat at the nearby (Fig. 55c) (Loc. 16), which so much resembles mangroves in appearance (including numerous pneumatophorata protruding from water) and conditions. The singular males (Fig. 55b) were also found twice, in different years, at a small, round, deep pool with a clear water formed by a sacred cold spring (Fig. 16) near the 1000 Linga (Siem Reap) River right bank. Not found elsewhere.

61. *Brachythemis contaminata* (Fabricius, 1793)

O.K.: **Loc. 1**: 11.12.2019: very many ♂♂, ♀♀ seen. **Loc. 5**: 14.06.2018: several ♂♂ seen. **Loc. 7**: 23.02.2017: 1 ♂, 1 ♀ seen; 11.06.2018: 1 ♂, 1 ♀ seen. **Loc. 8**: 12.06.2018: 1 ♂, 1 ♀ (maybe more) seen; 10.03.2019: several seen. **Loc. 10:** 10.03.2019: several seen. **Loc. 12:** 11.03.2019: many ♂♂, ♀♀ seen. **Loc. 18**: 10.03.2019: several seen. **Loc. 19**: 10.03.2019: many ♂♂, ♀♀ seen; 29.11.2019: 1 ♀ seen at the small pond. **Loc. 23**: 10.03.2019: very many ♂♂, ♀♀ seen. **Loc. 26**: 14.06.2018: quite many seen; 1.07.2018: many seen; 3.11.2018: 1 ♂ seen.
E.S.: **Loc. 1**6: 28.07.2019: ♂. **Loc. 19**: 12.06.2019: ♂. **Loc. 23**: 10.03.2019: ♂. Not located: 7.03.2019: ♂, ♀.

Observations. An omnipresent and eurytopic species tolerating pollution but still preferring slow current water, so on Phnom Kulen occurring mostly at rivers. Curiously, several individuals were found in the spray zone, with moist rocks, just below the high Kulen Waterfall, that looked far from a typical habitat of this species.

62. *Cratilla lineata calverti* Förster, 1903

O.K.: **Loc. 13** (shady road in a forest patch nearby): 30.06.2018: uncertain sighting of several individuals at dusk.

E.S.: **Loc. 20:** 23.10.2019: ♂. Not located: 22.12.2018: ♀.

Photo by Caleb Jones (in Facebook group 'Natural Cambodia'): **Loc. 3**: ♀.

Observations. The species active always in deep forest shade, also while raining or in dusk. Surprisingly rare in Phnom Kulen, in spite of widespread suitable habitats.

63. *Crocothemis servilia* (Drury, 1770)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂, several ♀♀ seen. **Loc. 2:** 11.12.2019: 1 ♂ collected. **Loc. 19** (at the small pond): 29.11.2019: many ♂♂ seen. **Loc. 20** (at a shallow grassy bay): 29.11.2019: many ♂♂ seen. **Loc. 21:** 10.03.2019: many ♂♂ seen. **Loc. 25:** 2.12.2019: several ♂♂ seen. **Loc. 26**: 1.07.2018: severa1 ♂♂, 1 ♀, 1 ovipositing tandem seen; 1 ♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 7**: 23.02.2017: ♂. **Loc. 19**: 10.03.2019: ♂.

Observations. A common lentic species occurring where it finds suitable habitats, hence not so frequent in Phnom Kulen.

64. *Diplacodes nebulosa* (Fabricius, 1794)

O.K.: **Loc. 7**: 12.06.2018: 1 ♂ collected. **Loc. 12:** 11.03.2019: 1 ♂ collected, several ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 15:** 28.11.2019: many ♂♂, ♀♀ seen. **Loc. 16**: 28.11.2019: many ♂♂, ♀♀ seen. **Loc. 17**: 28-30.11.2019: several ♂♂, 1 ♀ seen. **Loc. 19** (at the small pond): many seen. **Loc. 20:** 28-29.11.2019: very many ♂♂, ♀♀ seen. **Loc. 21:** 29.11.2019: many ♂♂, ♀♀ seen. **Loc. 23**: 10.03.2019: 1 ♂ seen.

E.S.: **Loc. 20:** 5.11.2019: ♂, ♀.

Observations. A common lentic species confined to emerging vegetation, occurs also in similar conditions at river slow reaches.

65. *Diplacodes trivialis* (Rambur, 1842)

O.K.: **Loc. 1**: 11.12.2019: several ♂♂ seen. **Loc. 7**: 23.02.2017: 1 ♂ seen; 11.06.2018: 1 ♂ seen. **Loc. 8** (rocks above the waterfall): 11.06.2018: 1 ♂ photo. **Loc. 12** (at lotic pools on a road): 4.11.2018: 1 immature ♂ seen. **Loc. 15:** 28.11.2019: 1 ♂ seen. **Loc. 17**: 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ seen. **Loc. 20:** 29.11.2019: 1 ♂ seen. **Loc. 23**: 10.03.2019: many ind., 1 copula seen. **Loc. 26**: 3.11.2018: 1 immature ♂ seen; 2.12.2019: several ♂♂, 1 ♀ seen.

E.S.: **Loc. 10:** 20.03.2018: ♂. **Loc. 22:** 25.11.2019: ♂, ♀.

Observations. A common species more often seen at open places beyond water.

66. *Hydrobasileus croceus* (Brauer, 1867)

O.K.: **Loc. 4**: 14.06.2018: 1 ♂ seen. **Loc. 1**0 (an open reach upstream of the bridge): 30.06.2018: 1 ♂ seen. **Loc. 11** (above an open pool at the road): 17.06.2018: 1 ♂ collected; 30.06.2018: 1 ♂ seen. **Loc. 20:** 28.11.2019: 1 ♂ seen; 29.11.2019: 1 ♂ collected, many ♂♂ seen.

Observations. Males can be seen soaring high above open pools (Locs 4, 11) and reaches (Loc. 10) of streams. On 29.11.2019 they appeared unusually numerous at the Thal Dach Reservoir dam (Loc. 20), soaring above the water and the dam itself.

67. *Indothemis limbata* (Selys, 1891)

O.K.: **Loc. 20:** 29.11.2019: 3 ♂♂ collected, several more seen. **Loc. 23**: 10.03.2019: 1 ♂ collected, 1 more ♂ seen.

Observations. Found at Tnal Dach Reservoir (Loc. 20), with the overgrown banks and surface or relatively deep water seeming to be the typical habitat of the species, and at a grassy and boggy broadening of a brook crossing an open pasture (Loc. 23). Males perch on sticks and fly much over the water.

68. *Lathrecista asiatica* (Fabricius, 1798)

O.K.: **Loc. 7**: 4.11.2018: 1 ♀ photo.

E.S.: **Loc. 20:** 5.11.2019: ♂; 7.11.2019: ♀.

Photo by Timo Hartmann in Facebook group 'Natural Cambodia': **Loc. 4**: 21.09.2008: ♂.

Observations. A species common elsewhere in Cambodia, especially in the dry season, but for some reason rare in Phnom Kulen.

69. *Nannophya pygmaea* (Rambur, 1842) (Fig. 56)

O.K.: **Loc. 11:** 4.11.2018: 1 ♂ collected, 1 ♂ photo (Fig. 56, top). **Loc. 12:** 11.03.2019: many ♂♂, 1 copula seen. **Loc. 1**3: 11.03.2019: very many seen. **Loc. 17**: 28-30.11.2019: several ♂♂, ♀♀ seen; 29.11.2019: 1 ♂ collected. **Loc. 19**: 10.03.2019: 1 ♂ collected, several ♂♂ seen; 29.11.2019: several ♂♂ seen at the small pond. **Loc. 20:** 28-29.11.2019: several ♂♂ seen; 29.11.2019: 1 ♂ photo (Fig. 56, bottom). **Loc. 21:** 29.11.2019: 1 ♂ photo, many mature and immature ♂♂ seen.

E.S.: **Loc. 12:** 22.07.2019: ♀. **Loc. 18**: 10.03.2019: ♂; 25.11.2019: ♂. Not located: 24.04.2019: ♂; 5.11.2019: ♀; 25.11. 2019: ♂.

Observations. Confined to fine moist grass with thin leaves near shallow water, as a rule of slow sunny reaches of small streams or brooks. Remarkably common in Phnom Kulen, although absent from most visited broad river reaches with sandstone beds such as Locs 6-8. For some reason not yet found on the western plateau.

Figure 56. Males of Nannophya pygmaea**: a – in the forest brook valley of Loc. 11, 4.11.2018, , b – at the Tnal Dach Reservoir (Loc. 20), 29.11. 2019. O.K.**

Figure 57. A female of Neurothemis fluctuans **with a light yellowing wing coloration at the Srae Tbong River (Loc. 16), 27.10.2019, E.S.**

70. *Neurothemis fluctuans* (Fabricius, 1793) (Figs 57-59)

O.K.: **Locs 6-7**: 23.02.2017: many ♂♂ (all with the wing colour not yet saturated), ♀♀ seen. **Loc. 7**: 4.11.2018: several seen; **Loc. 11:** 4.11.2018: 1 ♀ collected; several ♂♂, ♀♀ seen; 10-11.03.2019: very many seen; 30.11.2019: several seen. **Loc. 12:** 11.03.2019: very many seen; 30.11.2019: many ♂♂, ♀♀ seen. **Loc. 13**: 11.03.2019: many seen. **Loc. 16**: 28.11.2019: many seen. **Loc. 17**: 28-30.11.2019: many seen. **Loc. 18**: 10.03.2019: several seen. **Loc. 19**: 10.03.2019: many seen; 28.11.2019: many seen; 29.11.2019: 1 ♂ photo. **Loc. 20:** 28-29.03.2019: very many ♂♂, ♀♀ seen, including tenerals. **Loc. 21:** 29.11.2019: many seen. **Loc. 23**: 10.03.2019: very many ♂♂, ♀♀ seen, including tenerals. **Loc. 26**: 1.07.2018: 1 ♂ seen; 2.12.2019: several seen.

E.S.: **Loc. 6**: 20.03.2018: 2 ♂♂; 11.04.2018: ♂; 13.12.2018: ♀. **Loc. 13**: 11.04.2018: androchromatic ♀. **Loc. 14:** 13.12.2018: androchromatic ♀. **Loc. 1**6: 27.10.2019: ♂, 2 androchromatic ♀♀ (Fig. 58a,c), ♀ with wings slightly coloured (Fig. 57). **Loc. 20:** 7.11.2019: ♂, androchromatic ♀ (Fig. 58d); 27.10.2019: androchromatic ♀. **Loc. 23**: 10.03.2019: ♂. By the forest road between **Loc. 6** and **Loc. 9** (13.5605 N, 104.1805 E): 19.04.2018: ♂ (with a straight border of the wing colour) (Fig. 59); 20.02.2016: androchromatic ♀; 3.03.2016: ♀ with wings slightly coloured. Not located: 19.04.2018: ♂; 3.07.2018: androchromatic ♀ (Fig. 58b); 7.12.2018: ♀ (wings slightly coloured);

Figure 58. Androchromatic females of Neurothemis fluctuans**: a, c – at the Srae Tbong River (Loc. 16), 27.10.2019 (the same place and date as the female with pale wing colour in Fig. 57)**; **b – Phnom Kulen, not located, 3.07.2018**; **d – at Tnal Dach Reservoir (Loc. 20), 7.11.2019. E.S.**

3.12.2018: androchromatic ♀; 22.12.2018: ♀; 7.03.2019: androchromatic ♀, ♀ with wings slightly coloured; 11.04.2019: androchromatic ♀; 12.04.2019: ♀.

Remarks. In Pnhom Kulen there is an unusually high proportion of androchromatic females of this species. Among 17 females photographed by E.S. almost at random 3 had clear wings, 4 had wings slightly coloured (Fig. 57) and 10 were distinctly androchromatic (Fig. 58). So, the proportion of females with coloured wings appears to be ca 82%, while they are usually a minority elsewhere. The coloured wing part in androchromatic females is shorter than in males and does not reach the pterostigma. Its colour in mature individuals is usually darker, blackish-brown rather than reddish-brown as in males, yet the abdomen is dark-reddish contrasting in its colour to the wings (similarly coloured in males). Such females were illustrated by Roland et al. (2011: fig. 9) from Banteay Srei. Those reported by Kosterin (2014: fig. 15) from Ratanakiri Province had a much more restricted coloured wing areas.

Figure 59. A male of Neurothemis fluctuans**: with an unusual, straight border of wing coloration from between Locs 6 and 9, 19.04.2018. E.S.**

The females with slightly coloured wings has a yellowish tint of this coloration (Fig. 57) while in the androchromatic females the tint is rather blackish-brown (Fig. 58), even in rather young individuals where the colour is rather slight (Fig. 58b). Those yellowish-winged females may be interpreted as the youngest ones, in which the wing coloration just started to form, as a distinct morph or even as heterozygotes for alleles of some gene responsible for the wing coloration. This issue is to be clarified experimentally.

The male photographed by E.S. on 19.04.2018 between Locs 6 and 9 had the unusual, straight wing colour border (Fig 59).

Observations. One of the most common and widespread dragonfly.

71. *Neurothemis fulvia* (Drury, 1773)

O.K.: **Loc. 1**: 11.12.2019: 1 ♂ seen. **Loc. 2:** 11.12.2019: 1 ♂ seen. **Loc. 4**: 6.11.2018: 1 ♂ seen. **Loc. 5**: 6.11.2018: 1 ♂ seen. **Loc. 6**: 1 ♂ collected (found dead, still soft). **Loc. 7** (a small pool on rocks): 12.06.2018: 2 ♂♂ seen; 4.11.2018: 1 ♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 12:** 11.03.2019: 2 ♂♂ seen. **Loc. 26**: 14.06.2018: 1 ♂ seen; 1.07.2018: 1 ♂ seen; 3.11.2018: 1 ♂ seen; 2.12.2019: 2 ♂♂ seen.

E.S.: **Loc. 7** (a small pool on rocks): 18.05.2018: ♂. **Loc. 8** (at the trade area above the waterfall): 16.03.2018: ♂. **Loc. 21** (S of the road, 13.5316 N, 104.183 E): 12.06.2019: ♀. Not located: 24.01.2015: ♂; 14.12.2015: ♂.

Observations. Common; the habitat preference is hardly traceable.

72. *Neurothemis intermedia atalanta* Ris, 1919

O.K.: **Loc. 4**: 6.11.2018: several seen at the river, many at a glade behind trees. **Loc. 5**: 14.06.2018: 1 mature ♂ photo; 6.11.2018: several seen.. **Loc. 7**: 23.02.2017:

1 ♀ seen; 11.06.2018: 1 mature ♂, 1 immature ♂ collected; 1 immature ♂, 1 mature ♀ photo. **Loc. 9** (a small glade above the waterfall): 12.06.2018: 1 ♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 11** (a dry cashew plantation nearby): 30.06.2018: 1 ♂ seen; 4.11.2018: quite many ♂♂, ♀♀ seen; 10.03.2019: 1 immature ♂ seen; 20.11.2019: many immature ind. seen. **Loc. 12** (a dry glades behind trees): 4.11.2018: several seen; 30.11.2019: several seen. **Loc. 17**: 29.11.2019: 1 ♀ seen. **Loc. 19**: 28.11.2019: 1 ind. seen. **Loc. 23**: 10.03.2019: 1 ♂ seen. **Loc. 26**: several immature ♂♂, ♀♀ seen.

E.S.: **Loc. 8**: 16.03.2018: ♀. By the road 1.5 km NW of **Loc. 6** (13.5743 N, 104.0892 E): 18.05.2018: ♂, ♀. Not located: 16.12.2018: immature ♂; 22.12.2018: ♂.

Observations. A common species, especially in the dry season, seen mostly in dry places beyond the water, e.g. in grassy glades or at cashew plantations.

73. *Neurothemis tullia* (Drury, 1773)

O.K.: **Loc. 1** (on the rice field): 11.12.2019: 1 ♂♂ seen. **Loc. 7**: 23.02.2017: several ♂♂, ♀♀ seen; 17.06.2018: 1 ♂ seen. **Loc. 19** (at a pond): 10.03.2019: several ♂♂, ♀♀ seen. **Loc. 20:** 29.11.2019: 1 ♀ seen. **Loc. 23**: 10.03.2019: several ♂♂, ♀♀ seen.

E.S.: **Loc. 6**: 20.03.2018: 1 ♀.

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: 04-06.2013: ♂.

Observations. A lentic species common elsewhere in Cambodia but not so frequent in Phnom Kulen where it was repeatedly found also at the main river of the eastern plateau.

74. *Onychothemis testacea* Laidlaw, 1902

O.K.: Locs 6-7: 11.06.2018: several ♂♂ seen. **Loc. 8**: 12.06.2018: 1 ♀ collected; 1 ♂ seen. **Loc. 9**: 17.06.2018: 1 ♂ seen; 1 ♂ photo; 30.06.2018: several ♂♂, 1 ♀ seen. **Loc. 10:** 12.06.2018: 1 ♂ collected, 1 more ♂ seen; 17.06.2018: several ♂♂ seen. **Loc. 12:** 4.11.2018: several ♂♂ seen. . **Loc. 19**: 29.11.2019: 1 ♂ seen. **Loc. 26**: 14.06.2018: 1 ♂ collected, 2 more ♂♂ seen; 1.07.2019: 1 ♂ photo, many ♂♂, 1 ovipositing ♀ seen.

E.S.: **Loc. 1**9: 14.05.2019: ♂; 25.11.2019: ♂.**Loc. 25:** 30.05.2019: ♂.

Observations. Occurs at rapids or at least fast river reaches, which may be quite shady, which the males patrol by perching on dry tree branches or thin lianas or bamboo branches above the water, fast flying over the surface and chasing other dragonflies. A female was observed (at Loc. 26) which oviposited over a root bunch on a branch emerging from water at a rapid.

75. *Orchithemis pulcherrima* Brauer, 1878 (Fig. 60)

O.K.: **Loc. 11:** 17.06.2018: 2 ♂♂ collected, 1 immature ♂ photo, many ♂♂ seen; 30.06.2018: 1 mature ♂ photo (Fig. 60b), many ♂♂, 1 ♀ (red form) seen. **Loc. 19**: (shady area): several ♂♂ seen. **Loc. 23**: 10.03.2019: 1 ♂ collected; 1 ♂ photographed (Fig. 60c).

E.S.: **Loc. 1**6: 28.07.2019: ♂; 27.10.2019: ♂, ♀ (red form, Fig. 60a). **Loc. 19**: 10.03.2019: ♂.

Observations. Occurs, usually together with *A. viola*, at shady overgrown brooks (Loc. 11, 23) or small rivers (Locs 16, 19) in evergreen forest or secondary dense shrubbery at its patches, where the bright-red abdomen of males is conspicuous even in dark conditions (Fig. 60b-c).

Figure 60. A female (a) and males (b-c) of Orchithemis pulcherrima**: a – at the Srae Tbong River (Loc. 16), 27.10.2019, E.S.; b – in the brook valley of Loc. 11, 30.06.2018, O.K.; c – shrubs at Ta Penh village (Loc. 23), 10.03.2019, O.K.**

76. *Orthetrum chrysis* (Selys, 1891)

O.K.: **Loc. 1**: 11.12.2019: several ♂♂ seen. **Loc. 2:** 11.12.2019: many ♂♂ seen. **Loc. 3**: 6.11.2018: 1 ♂ seen. **Loc. 4**: 6.11.2018: several ♂♂ seen. **Loc. 5**: 6.11.2018: several ♂♂ seen. **Loc. 6**: 23.02.2017: several ♂♂ seen; **Loc. 7**: 23.02.2017: several ♂♂ seen; 17.06.2018: 1 ♂ seen. **Loc. 10:** 30.06.2018: 1 ♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 11:** 30.06.2018: 1 ♂ seen; 17.06.2018: 1 ♂ seen; 4.11.2018: many ♂♂ seen; 30.11.2019: several ♂♂ seen. **Loc. 12:** 4.11.2018: several ♂♂ seen at lotic pools on a road; 11.03,2019: many ♂♂ seen; 30.11.2019: 1 ♂ seen at the small waterfall. **Loc. 13**: 11.03.2019: several ♂♂ seen. **Loc. 1**6: 28.11.2019: several ♂♂ seen. **Loc. 18**: 10.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: many ♂♂ seen; 28.11.2019: several ♂♂ seen; 29.11.2019: 1 ♂, 1 ♀ photo, many ♂♂ seen. **Loc. 20** (at the outlet stream): 28-29.11.2019: 1 ♂ seen. **Loc. 21:** 29.11.2019: several ♂♂ seen. **Loc. 23**: 10.03.2019: very many ♂♂, several copulae seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26**: 3.11.2018: 1 ♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6**: 16.03.2018: ♂. **Loc. 19**: 4.11.2018: ♂. **Loc. 22:** 25.11.2019: ♂. Not located: 15.05.2015: copula; 7.12.2018: ♂.

Observations. Very common at any river and rivulet but actually associated with shallow pools nearby, usually with black litter-covered bottom, rather than with main streams.

77. *Orthetrum glaucum* (Brauer, 1865) (Fig. 61a,d)

O.K.: **Loc. 2:** 11.12.2019: 1 ♂ photo (Fig. 61d). **Loc. 3**: 6.11.2018: 1 ♂ photo. **Loc. 7**: 23.02.2017: 1 ♂ seen; 4.11.2018: many ♂♂ seen. **Loc. 8**: 12.06.2018: 1 ♂ photo; 4.11.2018: many ♂♂ seen. **Loc. 11** (at an open roadside pool): 4.11.2018: 1 ♀ collected, 1 ♂ photo, few more ♂♂ seen. **Loc. 12:** 4.11.2018: l ♂ seen at lotic pools on a road; 30.11.2019: 1 ♂ seen at the small waterfall. Loc.20 (at the outlet stream): 28.11.2019: 1 immature ♂ photo.

E.S.: **Loc. 19**: 25.11.2019: ♂. **Loc. 22:** 25.11.2019: ♂, copula. Not located: 13.11.2012: ♂ (Fig. 61a); 16.11.2014: ♂.

Figure 61. Males of Orthetrum **spp.: a, d –** O. glaucum; **b –** O. sabina; **c –** O. neglectum; **a-b – Phnom Kulen, not located, 13.11.2012, E.S.**; **c-d – at the brook near the low western spur of the western plateau (Loc. 2), 11.12.2019, O.K.**

Observations. Occurs at open places at rivers, brooks, or seepages on roads. Less common than the previous species and associated with flowing water rather than pools, e.g. with shallow river arms or brooks. Males usually perch on stones or flat rocks.

78. *Orthetrum luzonicum* (Brauer, 1868)

O.K.: **Loc. 1** (on the rice field): 11.12.2019: several ♂♂ seen. **Loc. 2:** 11.12.2019: 1 ♂ collected, 1 ♂ photo, very many ♂♂ seen. **Loc. 13**: 11.03.2019: 2 ♂♂ seen. **Loc. 15:** 28.11.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: several ♂♂ seen; 29.11.2019: 1 ♂ seen at the river, many ♂♂ at the small pond. **Loc. 21:** 29.11.2019: many ♂♂ seen. **Loc. 23**: 10.03.2019: 1 subteneral ♂ collected; 1 subteneral ♂ photo, several more such ♂♂ seen.

E.S.: **Loc. 19**: 5.11.2019: ♂; 25.11.2019: ♂. **Loc. 20:** 23.10.2019: ♂. **Loc. 22:** 25.11.2019: ♂. **Loc. 23**: 10.03.2019: subteneral ♂.

Observations. Occurs at small open streams overgrown with grass, e.g brooks, river arms, especially of rivers flowing through flat grassy areas. There is some ecological correlation with the occurrence of taro/elephant ear plants (Colocasiae).

79. *Orthetrum neglectum* (Rambur, 1842) (Fig. 61c, 62)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂ seen. **Loc. 2:** 11.12.2019: 1 ♂ photo (Fig. 61c), many ♂♂ seen. **Loc. 6**: 23.02.2017: several ♂♂ seen; **Loc. 7**: 23.02.2017: several ♂♂ seen; 4.11.2018: 1 ♂ seen. **Loc. 8**: 4.11.2018: 1 ♂ seen. **Loc. 16**: 28.11.2019: 1 ♂ seen. **Loc. 19**: 29.11.2019: 1 ♂ photo, several ♂♂ seen. **Loc. 23**: 10.03.2019: many ♂♂, several copulae seen. **Loc. 25:** 2.12.2019: several ♂♂ seen. **Loc. 26:** 3.11.2018: 1 ♂ seen; 2.12.2019: 1 ♂ seen..

E.S.: **Loc. 7**: 23.02.2017: ♂. **Loc. 19**: ♂; 5.11.2019: copula (Fig. 62). **Loc. 22:** 25.11.2019: ♂. **Loc. 24:** 14.03.2020: ♂. Not located: 12.04.2019: ♂; 7.10.2019: ♂.

Observations. This species is common at open reaches of rivers; not observed at small brook except for that of Ta Penh (Loc. 23) where was numerous. Less numerous than *O. chrysis* and showing no connection to pools.

80. *Orthetrum sabina* (Drury, 1770) (Fig. 61b, 63)

O.K.: **Loc. 1**: 11.12.2019: very many ♂♂ seen. **Loc. 2:** 11.12.2019: many ♂♂ seen. **Loc. 4**: 6.11.2018: 1 ind. seen. **Loc. 7**: 23.02.2017: several ♂♂ seen; 4.11.2018: several seen. **Loc. 1**1 (the dry cashew plantation nearby): 30.11.2019: 1 ind. seen. **Loc. 12:** 4.11.2018: several ♂♂ seen at lotic pools on a road; 30.11.2019: several seen. **Loc. 16**: 28.11.2019: several seen. **Loc. 18**: 10.03.2019: several seen. **Loc. 19**: 10.03.2019: many seen (mostly at the pond); 28.11.2019: 1 ind. seen; 29.11.2019: many seen. **Loc. 20:** 29.11.2019: 1 ♂ photo (Fig. 63), many seen. **Loc. 23**: 10.03.2019: many seen. **Loc. 25:** 2.12.2019: 1 ♂ seen. **Loc. 26**: 3.11.2018: very many ♂♂ seen; 2.12.2019: very many seen.

E.S.: Not located: 13.11.2012: ♂ (Fig. 61b); 7.12.2018: ♀.

Observations. Occurs at open places, on the plateaux less common than on the lowlands. Usually associated with big open lentic water bodies or seepages at the sandstone banks of mountain rivers, but territorial males were observed patrolling the surface of rather a fast lowland river of Loc. 1 and perching on its

Figure 62. A copula of Orthetrum neglectum **at the O'Dar River near Anlung Thom village (Loc. 19), 5.11.2019, E.S.**

banks. At the Tnal Dach Reservoir, a male was found in tandem with a female of *Trithemis pallidinervis* (Fig. 63).

81. *Orthetrum testaceum* (Burmeister, 1839) (Fig. 64)

E.S.: Not located: 30.04. 2015: copula (Fig. 64).

Remarks. Identified by one photo (Fig. 64), by the male abdomen rather evenly broad and warm scarlet red and the red thorax, while in the similar *O. chrysis* the abdomen is tapering and colder crimson red and the thorax is dark brown. Unfortunately, there is no specimen to check in hand. From Cambodia, the species has been reported by one male collected in Kep (Kosterin 2011); in Thailand is more common in the south of the country (Hämäläinen & Pinratana 1999).

82. *Palpopleura sexmaculata* (Fabricius, 1787) (Fig. 65)

O.K.: **Loc. 15:** 28.11.2019: 1 ♂ collected.

E.S.: **Loc. 19**: 25.11.2019: 2 ♂♂, 1 ♀ (Fig. 65).

Observations. Occurs at small grassy pools, in our area formed by water streaming through grass. Rare in the territory considered.

83. *Pantala flavescens* (Linnaeus, 1758).

O.K.: **Loc. 1**: 11.12.2019: many seen. **Loc. 7** (over flat sandstone rocky area): 11-12.06.2018: many seen; 17.06.2018: many seen. **Loc. 8**: 30.06.2018: 2 ovipositing ♀♀ seen. **Loc. 12** (above a road): 4.11.2018: 1 ind. seen. **Loc. 15:** 28.11.2019: several seen **Loc. 19**: 29.11.2019: several seen. **Loc. 20** (above a shallow bay): 29.11.2019: several seen. Over the road on the NW plateau slope: 17.06.2018: many seen after a downpour.

Figure 63. An anomalous tandem of a male of Orthetrum sabina **and a female of** Trithemis pallidinervis **at the shallow SW corner of the Tnal Dach Reservoir (Loc. 20), 29.11.2019, O.K.**

Figure 64. A copula of Orthetrum testaceum **from somewhere in the Phnom Kulen eastern plateau, 30.04.2015, E.S.**

E.S.: By the road from Anlong Thom to Sangkae Leak (13.5497 N, 104.1810 E): 27.10.2019: ♀.

Observations. These dragonflies as a rule soar above open areas, usually forming loose swarms; they remain active under weak rains. Although the species is known to breed mostly in small temporary pools, two supposedly ovipositing females were observed (the only oviposition sighting) at the big and deep pool under the Kulen Waterfall. Unlike other libellulids making long ovipositing series, they soared 2-3 m above, descended to water to make touch it briefly with their abdomen and rose again.

84. *Potamarcha congener* (Rambur, 1842)

O.K.: **Loc. 20** (an isolated shallow pool at bank at the NW corner): 29.11.2019: 1 teneral ♀ collected.

Figure 65. A female (a) and male (b) of Palpopleura sexmaculata **at the O'Dar River near Anlung Thom village (Loc. 19), 25.11.2019, E.S.**

E.S.: **Loc. 7** (at a small pool on rocks): 18.05.2018: ♂. By the road from Anlong Thom to Sangkae Leak (13.5498 N, 104.1813 E): 27.10.2019: ♂

Photos by Peter Gartner in Facebook group 'Natural Cambodia': **Loc. 5**: 04-06.2013: ♂, ♀.

Observations. Prefers small stagnant pools with open banks, often dirty. The pool at Loc. 20 approached this preferred habitats, although had grassy banks. Rare in the area.

85. *Rhodothemis rufa* (Rambur, 1842)

O.K.: **Loc. 7**: 23.02.2017: 1 ♀ seen. **Loc. 12:** 11.03.2019: 1 ♂ collected, very many ♂♂ seen; 30.11.2019: several ♂♂, many ♀♀ seen.

Observations. In two different times of the year this species was found remarkably numerous at the open reach with a flat bottom and medium current of the main river of the eastern plateau (Loc. 12), where kept to grassy mats with abundant Colocasiae plants along the banks. More common in the lowlands of Siem Reap Province (Kosterin 2020b).

86. *Rhyothemis obsolescens* Kirby, 1889 (Fig. 66)

O.K.: **Loc. 4**: 14.06.2018: 2 ♂♂ collected, 1 more ♂ seen. **Loc. 6**: 11.06.2018: 1 ♂ photo (Fig. 66c), several ♂♂ seen; 12.06.2018: several ♂♂ seen. **Loc. 9**: 11.06.2018: 1 ♂ seen. **Loc. 11:** 17.06.2018: 2 ♂♂ seen; 30.06.2018: many ♂♂ seen. **Loc. 12:** 11.03.2019: several ♂♂ seen. **Loc. 23**: 10.03.2019: several ♂♂ seen.

E.S.: **Loc. 6**: 2.06.2019: ♂; 15.05.2019: ♂ (Fig. 66b). **Loc. 19**: 10.03.2019: ♂ (Fig. 66d); 14.05.2019: ♂. **Loc. 20:** 6.06.2019: ♂. Not located: 21.05.2014: ♂ (Fig. 66b); 30.04.2015: ♀; 15.05.2015: ♂; 24.04.2019: ♂♂; 27.07.2019: ♂ (Fig. 66e)

Observations. Quite common at slow reaches of small forest rivers and brooks with abundant evergreen forest vegetation at banks, where taro/elephant ear (Colocasiae indet.) is usually present. Not found in the lowland. Spends overcast weather at high tree branches and descends to streams in sunshine.

87. *Rhyothemis phyllis* (Sulzer, 1776)

O.K.: **Loc. 7**: 11.06.2018: 1 ind. seen. **Loc. 8**: 12.06.2018: many seen in a swarm over open trading area. **Loc. 12:** 11.03.2019: many seen. **Loc. 1**9: 10.03.2019: many seen. **Loc. 20:** 29.11.2019: 1 ♂ released. **Loc. 21:** 29.11.2019: 1 ind. seen. **Loc. 23**: 10.03.2019: very many seen.

Observations. Usually observed fluttering together with *R. variegata*, often in loose swarms, at glades and larger open places near rivers, usually at forest margins.

88. *Rhyothemis plutonia* Selys, 1883 (Fig. 67)

O.K.: **Loc. 7**: 11.06.2018: 1 ind. seen. **Loc. 1**1 (at the open pool at the road embankment): 30.06.2018: 1 worn out ♂ seen.

E.S.: **Loc. 20:** 6.06.2019: ♂ (Fig. 67 left). Not located: 26.07.2015: ♂; 15.06.2017: ♀ (Fig. 67 right); 24.04.2019: ♂♂.

Observations. Rarely occurs at small open places; usually perch high on tall bushes. Tends to occur together with much more widespread *R. phyllis* and *R. variegata*. So, at Loc. 7 met together with them in gaps of secondary tree growth apart from the river.

Figure 66. Males of Rhyothemis obsolescens**: a – the eastern plateau of Phnom Kulen, not located, 21.05.2014, E.S.; b – at the Siem Reap River upstream of the carvings (Loc. 6), 15.05.2019, E.S.; c – at the same place, 11.06.2018, O.K.; d – at the same river at Anlung Thom village (Loc. 19), 10.03.2019, E.S.; e – the eastern plateau, not located, 27.07.2019, E.S.**

89. *Rhyothemis triangularis* Kirby, 1889 (Fig. 68)

O.K.: **Loc. 12:** 11.03.2019: 1♂ seen.

E.S.: **Loc. 20:** 6.06.2019: ♂; 20.06.2019: ♂; 28.04.2020: teneral ♀ (Fig. 68). Not located: 24.04.2019: ♂♂.

Observations. Rare, prefers stagnant or slowly flowing water with abundant emergent, so met at the Tnal Dach Reservoir (Loc. 20) and an open reach of the Siem Riep River where it flows flat with grassy mats with taro/elephant ear along the bank (Loc. 11).

90. *Rhyothemis variegata* (Linnaeus, 1763)

O.K.: **Loc. 2:** 11.12.2019: 1 ♀ seen. **Loc. 7**: 11.06.2018: 1 ♀ seen; **Loc. 8**: 12.06.2018: many ♀♀ seen in a swarm over the open trading area; 30.06.2018: 1 ♀ seen under the waterfall. **Loc. 12:** 11.03.2019: many ♀♀ seen. **Loc. 19**: 10.03.2019: many ♀♀ seen. **Loc. 23**: 10.03.2019: very many ♀♀ seen.

Remarks. Females only; most probably just a female morph of the species known as *R. phyllis* (Kosterin 2010), which then would be a junior subjective synonym of *R. variegata*.

Observations. Observed fluttering usually together with *R. variegata* (of 8 localities were either of these species were found both were observed at 5).

Figure 67. Rhyothemis plutonia**: left – a male at the Tnal Dach Reservoir (Loc. 20), 6.06.2019, E.S.**; **b – a female, the Phnom Kulen eastern plateau, not located, 15.06.2017**; **E.S.**

91. *Tetrathemis platyptera* Selys, 1878

O.K.: **Loc. 3**: 14.06.2018: 1 ♂ collected. Loc. **4:** 6.11.2018: 1 ♂ photo, 1 ♂ seen at the same point.

Observations. Found at both visits by O.K. to the Kbal Spean River on the western plateau, but for some reason not elsewhere. In June a male was met at a round hole filled with water in one of big rocks through which the river descended from the carving area. In November two males were met resting closely to each other on dry branches at a deep pool in the calm river section upstreams of the carvings. In both cases those males were very cautious and immediately flew high to tree crowns (in the first case after some 10 min the male was found at his water hole again).

Figure 68. A teneral female of Rhyothemis triangularis **at the Tnal Dach Reservoir (Loc. 20), 28.04.2020**; **E.S.**

92. *Tholymis tillarga* (Fabricius, 1798)

O.K. **Loc. 17**: 28.11.2019: 1 ♀ seen. **Loc. 19**: 28.11.2019: very many ♂♂, ♀♀ seen in twilight. **Loc. 12:** 30.11.2019: several ind. seen. **Loc. 26**: 2.12.2019: 1 ♂ seen.

Observations. A common lowland species breeding in lentic, often polluted habitats from where it disperses broadly. Active mostly in twilight, at daytime resting in bushes remaining quite active and cautious. Not so often seen in Phnom Kulen, but found very numerous at Loc. 19 in November.

93. *Trithemis aurora* (Burmeister, 1839) (Fig. 69a)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂ seen, 1 ♂ photo (Fig. 69a). **Loc. 4**: 6.11.2018: several ♂♂ seen. **Loc. 7**: 23.02.2017: several ♂♂ seen; 11.06.2018: 1 ♂ seen. **Loc. 8** (rock above the waterfall): 17.06.2018: 1 ♂ seen; 4.11.2018: several ♂♂ seen. **Loc. 10:** 4.11.2018: 1 ♀ seen. **Loc. 12:** 11.03.2019: several ♂♂ seen; 30.11.2019: many ♂♂, 1 ♀ seen. **Loc. 13**: 11.03.2019: 1 ♂ seen. **Loc. 19**: 10.03.2019: several ♂♂ seen; 28.11.2019: several ♂♂ seen; 29.11.2019: many ♂♂ seen. **Loc. 20** (at the outlet):.28-29.11.2019: several ♂♂ seen. . **Loc. 21:** 29.11.2019: l ♀ seen. **Loc. 25:** 2.12.2019: many ♂♂ seen. **Loc. 26**: 14.06.2018: 2 ♂♂ seen; 1.07.2018: many ♂♂ seen; 3.11.2018: several ♂♂ seen; 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6**: 18.05.2018: ♂. **Loc. 8**: 23.05.2016: ♂. **Loc. 10:** 25.11.2019: ♂, ♀. **Loc. 19**: 5.11.2019: ♂. **Loc. 22:** 25.11.2019: ♂, ♀. **Loc. 25:** 27.11.2019: ♂. Not located: 7.11.2018: ♂♂; 23.10.2019: ♂.

Observations. Common at open reaches of rivers and brooks with open stony or sandy banks, both in the mountains and near their foothills.

94. *Trithemis festiva* (Rambur, 1842)

O.K.: **Loc. 1**: 11.12.2019: many ♂♂ seen. **Loc. 7**: 23.02.2017: many ♂♂ seen; 4.11.2018: many ♂♂ seen. **Loc. 8**: 4.11.2018: many ♂♂ seen. **Loc. 11** (at an open roadside pool):

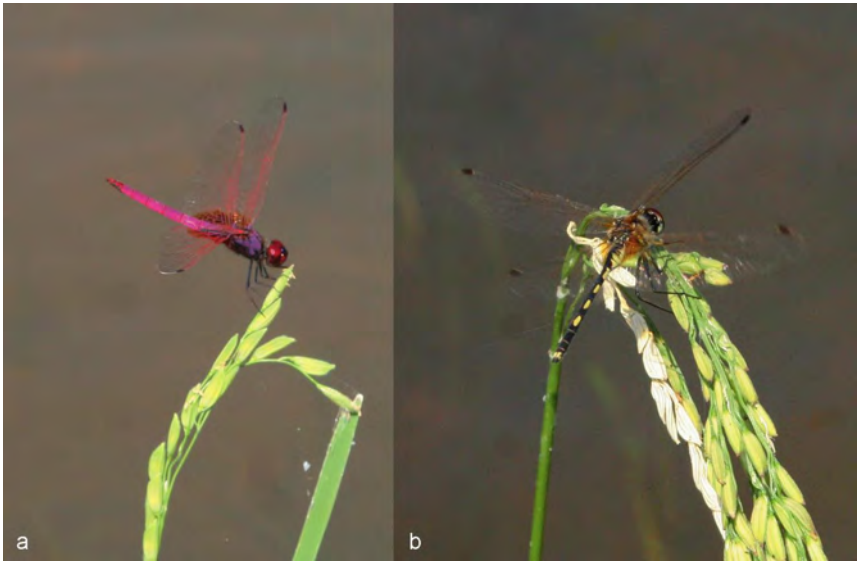

Figure 69. Males of Trithemis aurora **(a) and** T. pallidinervis **(b) perching on rice panicles at a field made in a flat bad of a river at the western spur of the western Phnom Kulen plateau (Loc. 1), 11.12.2019, O.K.**

4.11.2018: 1 ♂ photo, 1 more ♂ seen. **Loc. 12** (downstream of the small waterfall): 11.03.2019: 1 ♂ seen; 30.11.2019: several ♂♂ seen.. **Loc. 19**: 10.03.2019: 1 ♂ seen. **Loc. 25:** 2.12.2019: many ♂♂ seen.

E.S.: **Loc. 6**: 23.02.2017: ♂. **Loc. 19**: 10.03.2019: ♂; 5.11.2019: ♂; 25.11.2019: ♂. **Loc. 22:** 25.11.2019: ♂. Not located: 23.03.2014: ♂; 16.11.2014: ♂; 21.12.2014: ♂; 4.11.2018: ♂; 7.12.2018: ♂♂; 14.12.2018: ♂; 12.04.2019: ♂; 23.10.2019: ♂; 5.11.2019: ♂.

Observations. Less common than the previous species, prefers rapids at small streams; usually observed together with *O. glaucum*.

95. *Trithemis pallidinervis* (Kirby, 1889) (Figs 62, 69b)

O.K.: **Loc. 1**: 11.12.2019: 1 ♂ photo (Fig. 69b), many ♂♂ ♀♀ seen. **Loc. 7**: 4.11.2018: 1 ♂ photo. **Loc. 19** (at the small pond): several seen. **Loc. 20:** 28-29.11.2019: many seen; 29.11.2019: 1 ♀ photo (Fig. 62).

E.S.: **Loc. 19**: 25.11.2019: ♂. **Loc. 20:** 5.11.2019: ♂. Not located: 25.11.2019: ♂.

Observations. Prefers big, usually stagnant water in open landscapes, usually in lowlands. Hence in Phnom Kulen this species is common at the large reservoir of Tnal Dach (Loc. 20) and nearby but rare elsewhere. Surprisingly it was found common at the flat but still fast river just leaving the SW spur of the western plateau (Loc. 1). Curiously, males of all three species of *Trithemis* could be observed there perching at the panicles of rice planted right into the flat river bed (Fig. 70).

96. *Urothemis signata* (Rambur, 1842)

O.K.: **Loc. 10** (the open reach upstream of the bridge): 17.06.2018: 1 ♂ photo; 30.06.2018: 2 ♂♂ seen. **Loc. 17**: 28.11.2019: 1 ♂ seen. **Loc. 19** (at a pond): 10.03.2019: 1 ♂ seen. **Loc. 20:** 29.11.2019: several ♂♂ seen.

Observations. The species prefers big and deep ponds so is generally rare in Phnom Kulen; expectedly rather common at the banks of the big reservoir of Dnal Dach (Locl 20).

97. *Zygonyx iris malayana* Laidlaw, 1902 (Fig. 70)

O.K.: **Loc. 3**: 14.06.2018: 4 ♂♂ collected, several more seen; 6.11.2018: 1 ♂ seen. **Loc. 4**: 6.11.2018: several ♂♂ seen. **Loc. 6**: 11.06.2018: 1 ♂ collected; 12.06.2018: several ♂♂ seen. **Loc. 7**: 23.02.2017: several ♂♂ seen; 11.06.2017: several ♂♂ seen. **Loc. 8**: 12.06.2017: several ♂♂ seen; 17.06.2017: several ♂♂ seen. **Loc. 10:** 4.11.2018: ♂ seen. **Loc. 11:** 17.06.2018: several ♂♂ seen; 30.06.2018: 2 ♂♂ photo (Fig. 70d). **Loc. 12:** 4.11.2018: several ♂♂ seen; 11.03.2019: several ♂♂ seen. **Loc. 19**: 10.03.2019: 2 ♂♂ seen.

E.S.: **Loc. 13**: 11.04.2018: ♂ (Fig. 70b). **Loc. 19**: 10.03.2019: ♂; 5.11.2019: ♂ (Fig. 70a); 20.07.2019: ♂ (Fig. 70c); 6.06.2019: ♂. Not located: 23.03.2014: ♂; 7.10.2019: ♂.

Remarks. Some mature males (e.g. two of the four collected at Loc. 3 , that photographed at Loc. 13) are very dark, so that the brownish stripes on the thorax and base of abdomen are obscured and scarcely seen, while the fine yellow middorsal line is not noticeable by a naked eye (Fig. 70).

Observations. Common at rivers with stony beds and fast current, over which the males soar and hover, occurs at brooks with the same conditions.

Discussion

In spite of shortage of interesting findings, the revealed Odonata fauna of Phnom Kulen Mts appeared surprisingly rich, as counting 97 species, and in general well representative of Cambodia overall. This is because Phnom Kulen offers a variety of both lotic and lentic habitats. Not many gomphids were registered (7 species, of which one is lentic), mostly because a number of stream habitats most promising for them, namely Locs. 2, 15-18, 19 (the outlet), were found only in 2019 and were not examined in June. Such examination was planned for 2020 but failed due to the too well known reasons.

Of the 97 species revealed, only 17 have been hitherto reported for Phnom Kulen. Roland et al. (2011) recorded *V. gracilis, H. biforata, L. lineata* (the first report of this species for Cambodia), *C. marginipes, P. rubriceps, B. contaminata, D. trivialis, N. fulvia, O. chrysis, O. neglectum* (as *O. pruinosum neglectum*), *T. aurora and T. festiva* on 15.11.2010 at their locality 4 ("13°40,7412 N, 104°01,533 E") corresponding to our Loc. 5, the Kbal Spean River at the national park entrance, although this species assemblage would be expected more upstreams. Seehausen et al. (2016) reported *Nannophya pygmaea, N. fulvia, N. intermedia atalanta, O. luzonicum, O. sabina* and *R. obsolescens*, for Phnom Kulen without further verbal detail, while the coordinates provided ("13.7000° N, 104.0522° E") project to arable flatland at the northern foot of the eastern plateau, where *N. pygmaea* and *R. obsolescens* could hardly occur.

Figure 70. Darkened mature males of Zygonyx iris malayana**: a – at the O'Dar River near Anlung Thom village (Loc. 19), 5.11.2019, E.S.**; **b – at a brook flowing through open flat sandstone rocks (Loc. 13), 11.04.2018, E.S.**; **c - Loc. 19, 20.07.2019, E.S.**; **d - (Loc. 11), 30.06.2018, O.K.**

It was very interesting to find a complex of species confined to sluggish brooks shaded by evergreen rainforest, with slow current and dark silty bottom, such as *Archibasis viola, Brachygonia oculata, Orchithemis pulcherrima* (usually also accompanied by *Nannophya pygmea*). These three species have generally Sondaic ranges (Kosterin & Kompier 2018), were first found in coastal areas in SW Cambodia (Kosterin 2010; 2011; Day 2011) and are usually seen in coastal, often swamped lowland and foothill rainforests. Their presence contributes to an impression of Phnom Kulen as virtually an island, which it certainly was in the past when the Cambodian lowland still did not rise from the sea.

Macromia callisto is here reported for Cambodia for the first time. *Burmagomphus* sp. cf. *williamsoni* was also first found in this country in Phnom Kulen, and soon also in Preah Vihear Province (Kosterin 2020a), but needs further study. A very interesting record, the second in Cambodia after that on Phnom Dalai in the Cardamoms (Kosterin et al. 2012) is *Lestes nodalis* (unfortunately both Cambodian records of this species are still photographic only). The only photo of a mating pair of *Orthetrum testaceum* without precise location remains the only evidence of presence of this species, rare in Cambodia, in Phnom Kulen.

Phnom Kulen is a home of a recently described species *Microgomphus alani*, an undescribed species *Gomphidia* sp. and at least two unusual forms of uncertain taxonomical status, *Euphaea* sp. cf. *masoni* and *Burmagomphus* sp. cf. *williamsoni*, but all has been also recorded elsewhere, e.g. the two latter mentioned ones at less elevations more easterly, in Stung Treng (Kosterin 2017) and Preah Vihear Provinces (Kosterin 2020a), respectively.

In the context of its general richness the Phnom Kulen fauna of dragonflies and damselflies is even more remarkable for its omissions. No single representative of the genus *Coeliccia* and of the entire family Platystictidae were found, in spite of examination of many suitable habitats. All blue and blue-faced *Pseudagrion* males found on the Phnom Kulen appeared to be *P. australasiae* and checking many males from different localities in hand O.K. failed to find a single male of *P. microcephalum* Rambur, 1842, although both were found in the adjacent lowland. There *P. microcephalum* was found at the very banks of the great Lake Tonle Sap while *A. australasiae* at small lotic habitats elsewhere (Kosterin 2020b). These two very similar species tend to exclude each other from micro-habitats, although still can be not so rarely found together, e.g. in Ream Peninsula (Kosterin 2019c)

Remarkable was the absence of *Heliocypha perforata*, common on rocky streams elsewhere in Cambodia. Curiously, in absence of this species, males the related *H. biforata* did not show their usual preference of perching on vegetation but equally readily perch on streamside rocks, that is a common habit of *H. perforata*. Thus, in absence of a competitor the behavioural segregation of these two species is released. These species absences can be ascribed to the island position of the Phnom Kulen rainforest, so that some species or higher taxa failed to colonise or recolonise a remote habitat separated from their main ranges by exploited flatland.

Zyxomma petiolatum Rambur, 1842 could be overlooked for its crepuscular activity, since we managed to spend only three nights on Phnom Kulen. Absence of *Pseudothemis jorina* Förster, 1904, preferring calm, half-shaded deep lake or river reaches, which are common in Phnom Kulen, looks strange, especially in view that the species

was found at seemingly not so fitting habitat at the mouth of the Roluos Channel going from Phnom Kulen to Lake Tonle Sap (Kosterin 2020a). At the same time we do not think that absence in Phnom Kulen of records of *Anax* spp. means actual absence of these excellent flyers, so that *A. guttatus* is expected to be found there sooner or later. However an obvious general scarcity of aeshnids on Phnom Kulen should be admitted (but hardly explained).

Interestingly, Phnom Kulen appeared to be inhabited by *Burmagomphus* sp. cf. *willamsoni* while both south-eastern (Kosterin 2010; 2011; 2012; 2014) and eastern (Kosterin 2014; 2016b) Cambodia are inhabited by two other species of this genus, *divaricatus* Lieftinck, 1964 and *B. asahinai* Kosterin, Makbun & Davvrueng, 2012. It is unclear why *T. platyptera* has never been found on the eastern plateau while observed on both visits, made in the contrasting seasons, to the Kbal Spean River (Locs 3-4) on the western plateau.

Expectedly, most of the odonate life on the eastern plateau as well as on the foothill below is concentrated along its main river of so many names (O'Dar, Phey Thom, the River of 1000 Linga, Chup Preah, Siem Reap) and of reaches so different with respect of their natural conditions.

With exception of lotic dragonflies of the families Gomphidae and Synthemistidae confined to the rainy season, odonate assemblage of Phnom Kulen exhibits little or no seasonality so that most species can be found there in any time. This is understandable in that, standing amidst a perfect flatland, these plateaux receive some rains even in dry season.

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Miscellaneous faunal data on Odonata of Cambodia

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Abstract

Miscellaneous faunal data on Odonata are presented from four parts of Cambodia: the Cambodian Plain around Siem Reap (2017-2019), a Phnom Tbeng foothill in Preah Vihear Province (19.06.2018), Mondulkiri Province (June 2018) and the O'Som village environs in Pursat Province (March 2019). *Macromia flavocolorata* is for the first time reported for Cambodia. Some remarks and interesting observations are provided.

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Siem Reap Province, Preah Vihear Povince, Mondulkiri Province, Pursat Province

Introduction

In 2006-2019 I made 13 trips to Cambodia aimed to investigate hitherto very poorly known fauna of its Odonata. The faunal data obtained have been published mostly in International Dragonfly Fund Report journal (issues 29, 40, 42, 45, 67, 89, 98, 101, 105, 123, 129, 132), the flexible format of which allowed to extensively illustrate dragonflies and damselflies themselves as well as their habitats, while taxonomical papers concerning Cambodian Odonata were published in a number of journals. Some pieces of faunal data obtained before the pandemic break of these research remained unpublished and are presented herewith. They refer to the plains of Siem Reap Province between the Phnom Kulen Mts. and Lake Tonle Sap (mostly the temple area), a short stop at the Phnom Thmei foothill in Preah Vihear Province, new data from Mondulkiri Province and small data from Pursat Province.

I. Plains of Siem Reap Province

Siem Reap Province is situated in the north-west of Cambodia and is interesting for two unique natural objects, the great Lake Tonle-Sap and a small isolated plateau of the Phnom Kulen Mts. On my five trips in 2017-2019 I focused on investigation of their Odonata but also collected some data from the plains between them, mostly from the environs of Siem Reap City, where I was based, and also from the Angkorian temple complex. The area considered here extends from the West Baray Reservoir (103.76°E) in the west to Ben Melaea Temple (104.23°E) in the east and from Chreav village (13.31°N) in the south to the Siem Reap River at 13.49°N in the north. So outlined, it does not include the plains temporarily inundated by Lake Tonle Sap, considered in the paper devoted to the lake (Kosterin 2020a) and the Siem Reap River at and upstream of

Banteay Srey village flowing already on a plain but still close to the Phnom Kulen Mts, considered in (Kosterin 2020b), but includes Ben Melaea Temple area up to 43 km ENE of Siem Reap.

Although this area includes the famous temples of the Angkorian complex, just six communications reported some earlier findings of Odonata there, made in 1964 (Asahina 1967), 2003 (Seehausen et al. 2016), 2005-2006 (Benstead 2006), 2006 (Kosterin & Vikhrev 2006) and 2010 (Roland & Roland 2010; Roland et al. 2011). Here I present modest data mostly obtained in dry season, on February 21-March 1 of 2017 and November 1-10, 2018, with a minor addition of December 2019 and June 2018.

Figure 1. Semi-evergreen forest retained at Bayon (top left) and Banteay Kdel (top right and below) Temples. 22.02.2017.

Figure 2. A pond (a) and the moat (b) at Angkor Wat Temple. 8.01.2006.

The vast area between Lake Tonle Sap and the Phnom Kulen Mts (37-50 km apart) is a farmland: mostly rice fields, some pastures, secondary tree growth, a lot of picturesque Palmyra Sugar Palm (*Borassus flabellifer* L.) growing semi-naturally (but having appeared in Cambodia only ca thousand years ago). At the same time tall semi-evergreen forest is retained in the territories of the famous temples of the Angkorian complex (Fig. 1), which also abound with ponds (Fig. 2a) and moats (Fig. 2b), good for lentic odonates.

Localities:

SR1: 2 km NE Preah Dak village, Prasat To ruins (two twin small towers, the most ancient pre-Angkorian relic). Secondary tree stand along the former wall of the ancient reservoir East Baray; a shallow ancient channel; a grassy swamp with grazing buffaloes in the former bottom, 13.456-457°N, 103.955-956°E, 30-31 m a.s.l. 21.02.2017.

SR2: the Siem Reap River 16 km NE of Siem Reap, at the bridge: deep and slow, with big bays, apparently dammed downstream, with turbid water; the high right bank with a clayey bluff and adjacent large bush thickets. 13.489-490°N, 103.921°E, 31-32 m a.s.l. 21.02.2017, 3.12.2018.

SR3: Sra Srang basin (Fig. 3) in the Angkor temple complex, with clear water and sandy banks, mostly barren but with sparse emerging grass at some places, 13.429-431°N, 103.903-904°E, 28-32 m a.s.l. 22.02.2017.

Figure 3. Sra Srang basin in the Angkor temple complex. 22.02.2017. Habitat of P. rubriceps, I. decoratus, D. trivialis, O. sabina, T. pallidinervis**.**

SR4: Banteay Kdel Temple, a muddy pool with emerging grass (including *Marsilea* sp.) in tall semi-evergreen dipterocarp forest. 13.430-431°N, 103.900-901°E, 30-35 m a.s.l. 22.02.2017.

SR5: Baphuon Temple, a sunny shallow grassy pool with flat banks in front of the entrance, with slime algae, *Ludwigia adscendens* (L.) H. Hara, *Ipomoea aquatica* Forssk, *Mimosa* sp., *Marsilea* sp., some dead bushes. 13.4440-4442°N, 103.8584-8586°E, 37 m a.s.l. 22.02.2017.

SR6: Very large swamps filled with lotus (*Nelumbo nucifera* Gaertn.) and/or water hyacinth (*Eichhornia crassipes* (Mart.) Solms) at the SW corner (230 m W to 390 m SW) of the West Baray Reservoir (Fig. 4). Some banks with a floating grassy bog with *Marsilea* sp.; some channels with clear water used for snakehead fishing. Secondary thickets, small pastures and long fallow lands, patches of dipterocarp forest at banks. 13.422-424°N, 103.761-763°E, 15-17 m a.s.l. 25.02.2017, 1 and 3.11.2018, 4.12.2019 (a very brief examination this day).

SR7: The S bank of the West Baray Reservoir. The bank is clayey, with very scarce grass and bushes of *Mimosa pigra* L., almost barren; the water is rather clear, deep already at the bank but very warm. Rather a lifeless place. 13.425°N, 103.764-785°E, 18-20 m a.s.l. 25.02.2017, 1.11.2018.

SR8: The outlet channel of the West Baray Reservoir, very deep with clear water and slow current, bordered by tall trees (Fig. 5). 13.420-425°N, 103.765-787°E, 18-20 m a.s.l., 25.02.2017.

Figure 4. Large swamps at the SW corner of the West Baray Reservoir (SR6). 1. (above) and 3. (below). 11.2018. Habitat of not less than 14 odonate species (Table 1).

Figure 5. The outlet channel of the SW corner of the West Baray Reservoir (SR8). 25.02.2017. Habitat of I. decoratus, B. contaminata, B. chalybea, N. tullia, O. sabina.

SR9: a brook in a populated area, with a rust-coloured bottom, partly in open area trampled with cattle (with numerous frogs), partly shaded with secondary tree stand. 13.391-392°N, 103.860-861°E, 20-21 m a.s.l. 21.02.2017.

SR10: the Siem Reap River right bank in the Siem Reap City, at and upstream of the Night Market. The river is large and slow, the bank is shallow, at the time of examination covered with flowering semiaquatic *L. adscendens* (Fig. 6) and sparse *Nymphaea* sp. 13.353-355°N, 103.856-858°E, 20-21 m a.s.l. 21.02.2017.

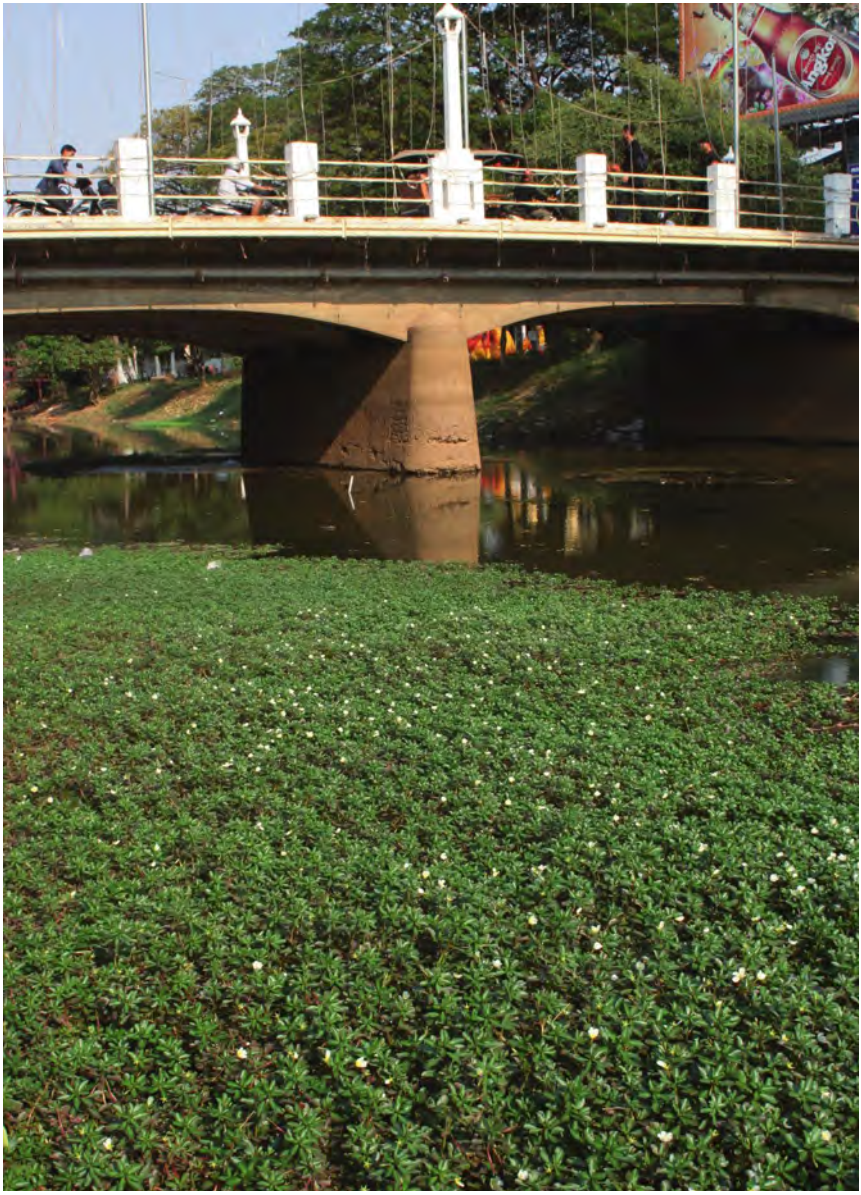

Figure 6. The Siem Reap River in the Siem Reap centre (SR10), with lot of Ludwigia adscendens**. 21.02.2017. Habitat of** A. minima, A. pygmaea, I. senegalensis, P. microcephalum, A. panorpoides, B. contaminata, C. servilia, D. nebulosa, D. trivialis, R. phyllis, R. variegata, T. pallidinervis**.**

SR11: a big pond at Chreav village, with grassy banks, a small floating bog at one of them and a lotus thicket at another, 5.5 km SE Siem Reap, 10.2 km NNE of the Lake Tonle Sap N bank. 13.320 -- 321°N, 103. 885-886°E, 12-13 m a.s.l. 1.03. 2017.

SR12: the remnants of an ancient channel used for transportation of rock blocks to the temple area (presently crossed with many dams). A broad tree-shaded part with high banks and brown sucking bottom; nearby an open shallow part with similar bottom overgrown with lotus. 13.4442°N, 104. 1696°E, 3.12.2018.

Figure 7. Close and of similar size but different ponds in front of Ben Melaea Temple (SR15); **a – covered with water cabbage etc.**; **b – covered with lotus**; **c – with some** Azolla**. 27.02.2017.**

SR13: the big O'Tma Dap River at the bridge near Ben Melaea Temple, with turbid water and high banks with secondary growth of trees and *Mimosa* sp. 13.4442°N, 104.1696°E, 19.06.2018.

SR14: The N moat of Ben Melaea Temple: a typical Cambodian small stream with a bed of sandstone rocks surrounded with trees, at the time of examination without current, with pools up to waist-deep. 13.479°N, 104.229°E, 81-82 m a.s.l. 27.02.2017.

SR15: Four small ponds at Ben Melaea Temple, some 20 m in diameter (Fig. 7). One of them was completely covered with water cabbage (*Pistia stratiotes* L.), with participation of water hyacinth, *Salvinia cucullata* Roxb., *L. adscendens* and *Nymphaea* sp. (Fig. 7a); another filled with lotus, with participation of water hyacinth and *L. adscendens* (Fig. 7b); the two other ones with almost open surface with some *Azolla* sp. (Fig. 7c). A lot of *Hylarana erythraea* (Schlegel, 1837) frogs at the two former ones. Surrounded with tall deciduous dipterocarp forest, drier than in the Siem Reap environs (Fig. 8): trees without leaves in February.13.4739-4744°N, 104.2272-2300°E, 80 m a.s.l. 27.02.2017.

SR16: The S moat of Ben Melaea Temple: a very broad and deep pond covered with floating grassy bog with participation of lotus and Colocasiae indet.; cleared from that vegetation for 20 m along the road, with open water with sparse lotus, water hyacinth and water cabbage. 13.472°N, 104. 229 °E, 80 m a.s.l. 27.02.2017.

Figure 8. Dry forest at Ben Melaea Temple. 27.02.2017.

Results and Discussion. The Odonata observed, collected and photographed in the above listed localities are enumerated in Table 1. It includes 52 species well representing the most common ones in the Cambodian Lowland. *Camacinia gigantea* Brauer, 1867 is the only one which I have never seen in Cambodia before (three males perched high on dead bushes of *Mimosa pigra* (Fig. 14) above a shallow pond at Baphuon Temple (SR5) at midday, and one male was hovering at one place above the small pond covered with water cabbage at Ben Melaea temple (SR15) in the morning but was not seen at midday).

In 2017-2019 I did not come across four species earlier recorded in literature for the area considered. Asahina (1967) reported *Gynacantha subinterrupta* Rambur, 1842 and *Zyxomma breviventre* (Martin, 1921) (as *Zyxommoides breviventre*) from Angkor Wat, and the latter species also by Seehausen et al. (2016) by specimens attracted by light at two localities, of which one (Angkor Thom) was near SR5. *Aciagrion borneense* Ris, 1911 and *Tramea ?transmarina* (an unclear sighting) were reported from Angkor Wat Temple, and the latter species and *Lestes concinnus* Hagen in Selys, 1862 were reported from the Siem Reap Airport area by myself (Kosterin & Vihkrev 2006). Benstead (2006) reported *Ictinogomphus rapax* (Rambur, 1842) as 'common' in Angkor Wat versus *I. decoratus* (Selys, 1854) as 'single' there: no doubt those specimens were *I. decoratus* (while the Oriental *Ictinogomphus* spp. require a complete revision).

Photographs of not less than 17 more species were presented for the considered area in the Facebook group 'Natural Cambodia' by the small local naturalist community of Siem Reap City. There is no geolocation and some of the locality annotations are too general, e.g. 'Siem Reap' or 'near Siem Reap', which in fact could even refer to the Phnom Kulen Mts. with very different environmental conditions and odonate assemblage. But quite a number of good findings are well documented. These public science data will be summarised and published elsewhere.

Figure 9. A mature male of Ceriagrion olivaceum **at a forest pool in Banteay Kdel Temple territory (SR4). 22.02.2017.**

Table 1. Odonata registered in the Siem Reap area (in locs SR1-SR16, see the text). The month of visit is indicated; **the visits to SR2, SR6 and SR7 at different month are considered separately. Codes of abundance: - – not found, 1 – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals, of any sex), 3 - moderately abundant (6-20), 4 – abundant (~20-100)**; **underlining indicates that some specimen(s) was (were) collected at this locality, boldface – that the species was photographed in nature there**; **other registrations are sightings. The provenance of two species found beyond the coded localities is given in footnotes.**

Localities	SR1	SR2	SR2	SR3	SR4	SR5	SR6	SR6	SR6	SR7	SR7	SR8	SR9	SR10	SR11	SR12	SR13	SR14	SR15	SR16
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
Calopterygidae																				
1. *Vestalis gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Chlorocyphidae																				
2. *Libellago lineata*	-	1♀	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lestidae																				
3. *Lestes elatus*[1]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coenagrionidae																				
4. *Aciagrion pallidum*	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
5. *Agriocnemis minima*	3	-	-	-	-	-	3	-	-	-	-	-	-	3	3	1♀	-	-	-	3
6. *Agriocnemis nana*	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. *Agriocnemis pygmaea*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-
8. *Ceriagrion auranticum*	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	2
9. *Ceriagrion cerinorubellum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♀	-	-
10. *Ceriagrion malaisei*[2]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11. *Ceriagrion olivaceum*	-	-	-	-	1♂ (Fig. 9)	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-
12. *Ceriagrion praetermissum*	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	3	-	-	2 (Fig.10)	-
13. *Ischnura senegalensis*	-	-	-	-	-	-	-	-	1♀	1♂	-	-	-	4	4	-	-	-	-	-
14. *Paracercion calamorum dyari*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
15. *Pseudagrion australasiae*	1♂	-	-	-	-	-	-	-	-	-	-	?2	-	-	3	2	-	-	-	-
16. *Pseudagrion microcephalum*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
17. *Pseudagrion rubriceps*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Localities	SR1	SR2	SR2	SR3	SR4	SR5	SR6	SR6	SR6	SR7	SR7	SR8	SR9	SR10	SR11	SR12	SR13	SR14	SR15	SR16
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
Platycnemididae																				
18. *Copera marginipes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	**2**	1♂	-	-
19. *Onychargia atrocyana*	-	-	-	-	-	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
20. *Pseudocopera ciliata*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1♂	-	-	-
21. *Prodasineura autumnalis*	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
Gomphidae																				
22. *Ictinogomphus decoratus melaenops.*	-	-	-	2	-	-	-	-	-	-	-	**2 (Fig. 11c)**	2	-	-	-	-	**2 (Fig. 11a-b)**	-	-
Macromiidae																				
23. *Epophthalmia frontalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
Libellulidae																				
24. *Acisoma panorpoides*	-	-	-	-	-	-	3	1♀	-	-	-	-	-	2	1♀	-	-	-	-	-
25. *Aethriamanta aethra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂ (Fig. 12a)	2
26. *Aethriamanta brevipennis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	2 (Fig. 12b)	2
27. *Brachythemis contaminata*	-	4	-	4	-	-	2	4	-	4	-	2	2	4 (Fig. 13)	4	-	-	2	-	2
28. *Brachydiplax chalybea*	-	-	-	-	-	-	2	3	-	-	-	**1♂**	-	-	-	4	-	-	2	3
29. *Brachydiplax farinosa*	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
30. *Camacinia gigantea*	-	-	-	-	-	2 (Fig. 14)	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-
31. *Crocothemis servilia*	-	2	-	2	2	3	2	-	3	2	-	-	-	**3**	2	1♂	-	3	2	2
32. *Diplacodes nebulosa*	-	-	2	-	-	-	-	4	-	-	3	-	-	2	2	-	-	-	-	-
33. *Diplacodes trivialis*	-	1♂	-	1♂	-	-	-	4	-	-	3	-	-	1♂	-	-	-	-	-	-
34. *Hydrobasileus croceus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-

Localities	SR1	SR2	SR2	SR3	SR4	SR5	SR6	SR6	SR6	SR7	SR7	SR8	SR9	SR10	SR11	SR12	SR13	SR14	SR15	SR16
Month when visited	Feb.	Feb.	Dec.	Feb.	Feb.	Feb.	Feb.	Nov.	Dec.	Feb.	Nov.	Feb.	Feb.	Feb.	Mar.	Dec.	Jun.	Feb.	Feb.	Feb.
35. *Lathrecista asiatica*	-	-	-	-	-	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
36. *Neurothemis fluctuans*	1♀	-	-	-	**2 (Fig. 15)**	-	-	2	-	-	-	-	-	-	-	1♂	-	-	-	-
37. *Neurothemis fulvia*	2	-	-	-	2	-	-	3	2	-	-	-	2	-	-	-	-	2	-	-
38. *Neurothemis intermedia atalanta*	-	-	-	-	1♀	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
39. *Neurothemis tullia*	2	-	2	-	**3**	-	2	4	2	1♂	-	-	-	-	2	-	-	-	1♀	2
40. *Orthetrum chrysis*	1♂	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1♂	-	-	-	-
41. *Orthetrum sabina*	2	-	2	**3**	2	-	2	-	3	3	3	3	2	-	2	3	-	2	2	2
42. *Pantala flavescens*	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	2	-
43. *Potamarcha congener*	-	-	**1♀**	-	-	-	1♀	-	-	-	-	-	1	-	-	-	-	1♂	1♂	-
44. *Pseudothemis jorina*	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-
45. *Rhodothemis rufa*	-	-	-	-	1♀	-	2	3	-	-	-	-	-	-	-	-	-	-	3	-
46. *Rhyothemis phyllis*	-	-	-	-	2	2	4	**4**	-	-	-	-	1	4	1	2	-	1	1	-
47. *Rhyothemis variegata*	-	-	-	-	2	2	4	**4**	-	-	-	-	1♀	**4**	-	1♀	-	-	-	-
48. *Tholymis tillarga*	-	-	-	-	**1♀**	-	-	1♀	3	3	-	-	-	-	-	-	-	-	-	1♂
49. *Trithemis aurora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
50. *Trithemis pallidinervis*	-	3	2	1	-	3	-	-	-	4	-	-	-	2	1♂	-	-	-	-	-
51. *Urothemis signata*	-	-	-	-	-	-	2	-	2	-	3	-	-	-	1♂	2	-	-	2	3
52. *Zyxomma petiolatum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?1	**1♀ (Fig. 16)**	-	-	-

1 A male was found at 2 a.m. on 21.12.2019 attracted by light to Damnak Riverside Guesthouse in Siem Reap (13.3505° N, 103.8557° E)
2 A male collected at Phnom Bakeng on 11.95.2018 was offered by Christophe Guenole

Figure 10. A male of Ceriagrion praetermissum **at a pond with water cabbage in front of Ben Melaea Temple (SR15) (Fig. 7a). 27.02.2017.**

Figure 11. Ictinogomphus decoratus melaenops**: a-b – a female at the West Baray outlet channel (SR8**; **Fig. 5), 25.02.2017**; **c – a male at Ben Melaea Temple northern moat (SR14), 27.02.2017.**

Remarks. 1. The male of *Ceriagrion olivaceum* Laidlaw, 1914 collected on 23.02.2017 at SR4 looked somewhat 'too colourful' for this mostly dull-coloured species as having the abdomen reddish above and the thorax distinctly greenish (Fig. 9). However, I have seen at least one such specimen at Pattaya, Thailand (considered as *C. ?indochinense* in Kosterin & Vikhrev 2008), and the reddish abdomen is mentioned in literature on this species. It seems that this is a coloration of fully adult males of this species while an observer more frequently sees immature males and females on their dispersal from water, which are dull ochraceous indeed.

2. A male of *Neurothemis fluctuans* (Fabricius, 1793) photographed at Banteay Kdel Temple (SR4) had the wing coloration unusual in being very uneven, slight at wing bases and becoming earthy-blackish to the outer margins of the coloured area, which was shorter than usual in this species, not reaching the pterostigmata (Fig. 15). This appearance could even suggest a possible introgression from *N. tullia* (Drury, 1773), although the body was coloured normally for young *N. fluctuans*.

Figure 12. Males of Aethriamanta aethra **(a) and** M. brevipennis **(b) at the pond with water cabbage in front of Ben Melaea Temple (SR15) (Fig. 7a), 27.02.2017.**

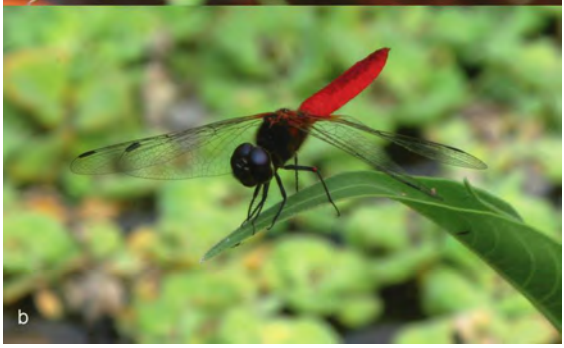

Figure 13. Males of Brachythemis contaminata **at the Siem Reap River in the Siem Reap centre (SR10) (Fig. 6), 21.02.2017.**

Figure 14. A male of Camacinia gigantea **at a pond at Baphuon Temple (SR5). 22.02.2017.**

Figure 15. A young male of Neurothemis fluctuans **with an unusual wing coloration in the forest in the Banteay Kdei Temple territory (SR4). 22.02.2017.**

Figure 16. A female of Zyxomma petiolatum **in thickets at the O'Tma Dap River right bank near the bridge (SR13). 19.06.2018.**

Observation. It was remarkable how the four small, shallow pools situated very closely to each other at Ben Melaea Temple (SR15) differed in both vegetation (Fig. 7) and odonate communities (by 27.02.2017). The surface of two of them had scarce *Azolla* (Fig. 7c); the dragonflies were represented by few males of *Brachydiplax chalybea* Brauer, 1868, *Crocothemis servilia* (Drury, 1770), *Pantala flavescens* (Linnaeus, 1758), *Orthetrum sabina* (Drury, 1779) and one soaring male of *Hydrobasileus croceus* (Brauer, 1867). The surface of another one was completely covered with water cabbage (Fig. 7a) and it offered a rich odonate assemblage including several *Ceriagrion praetermissum* Lieftinck, 1929 (Fig. 10), *Aethriamanta brevipennis* (Rambur, 1842) (Fig. 12b), *C. servilia*, *Urothemis signata* (Rambur, 1842) and singular males of *Aethriamanta aethra* (Ris, 1912) (Fig. 12a), *Camacinia gigantea* Brauer, 1867, *Potamarcha congener* (Rambur, 1842), *Rhyothemis phyllis* (Sulzer, 1776). Besides, in the morning a small black-winged libellulid oviposited between the water cabbage rosettes, which may have been an androchromatic female of *N. tullia*. The rest pool was overgrown with tall lotus (Fig. 7b) and inhabited almost exclusively by plentiful *Rhodothemis rufa* (Rambur, 1842) (these dragonflies mostly perched on the lotus petioles keeping their abdomen oriented along the latter), along which I found only a male of *B. chalybea* and a teneral male of *C. praetermissum*.

II. Phnom Tbeng foothill

Phnom Tbeng is a narrow curved plateau ca 40 km long and 12 km wide at the broadest place, with the highest place ca 490 m a.s.l. and very steep N and E slopes; at its eastern foot the Preah Vihear Province capital, Tbeng Meancheay City (Krong

Preah Vihear) resides. The plateau is covered with dense, rather undisturbed evergreen forest. It quite resembles the Phnom Kulen Mts in Siem Reap Province (Kosterin 2020b) but is almost unexplored, that is surprising even in spite of its being Phnom Tbeng Natural Heritage Park. About midday 19.06.2018 we had a very short, ca half an hour stop at the base of its N slope, at 13.7771°N, 104.8703°E, ~140 m a.s.l., 12 km WSW Tbeng Meanchay City. This stop is worth mentioning since a rare dragonfly was photographed. I found a tiny turbid brook flowing from a shady pool under a picturesque vertical cliff and startled a greenish-greyish aeshnid female with a yellow face which sat on a dry branch above the pool. It was cautious and when disturbed it relocated to a nearby branch in a rounded niche in the rock. I took a photo (Fig. 17), then returned to the car for a net and came back but missed the stroke. Although the photo is poor, it shows the main veins suggesting Gynacanthinae (unfortunately it does not show crossveins). *Gynacantha* is excluded because of a cylindrical abdomen without waist, *Tetracanthagyna* because of a modest size, by exclusion the photo suggests *Heliaeschna*. *H. crassa* Krüger, 1899 is excluded because of missing dark strokes at the wing bases and, again, by smaller size, *H. uninervulata* (Martin, 1909) is excluded because greenish tones are very scarce. The dull grey body with scarce greenish tone at S1-S2 and yellow face suggest *H. simplicia* (Karcsh, 1891), so far known from Cambodia by a single male from Koh Kong Province (Kosterin & Chartier 2014). Of other Odonata only several individuals of *Vestalis gracilis* (Rambur, 1842) were seen at that place.

III. Mondulkiri Province

Odonata of Mondulkiri Province were studied by me for ten days in June 2014, the results being reported detail in Kosterin (2016, plus a number or taxonomic papers referenced therein). On June 23-28, 2018 I revisited mostly the same area but also examined some places further north-east. The earlier published results of that trip include the description of *Macromidia genialis buusraaensis* Kosterin 2018 (Kosterin 2018a), rediscovery of *Lestes nigriceps* Fraser, 1924 (Fig. 18) (Kosterin 2018b) and an update to the knowledge, with a female description, of *Microgomphus alani* Kosterin, 2016 (Kosterin 2019). The detailed description of the terrain is given in (Kosterin 2016). Of 16 localities examined in 2018, 4 were also studied in 2014 (Kosterin 2016), while 12 were studied anew (see below).

Localities:

M1: 12.5 km SSW of Sen Monorom, 3 km NE of O'Rang village, a rivulet making a loop on an open area bordered with trees, flowing slowly through low Poaceae grass, 12.3463-3468°N, 107.1704-1708°E, 678-680 m a.s.l. 28.06.2018.

M2: 11.5 km S of Sen Monorom, 5 km NE of O'Rang, a deep and fast river meandering in open grassland at the bridge. It falls via a small waterfall into a pool with high earthy banks and then hides in forked ferns and trees, 12.3586°N, 107.1822-1829°E, 682 m a.s.l. 28.06.2018.

M3: 6 km S of Sen Monorom, the waterfall at the O'Romis river (upstream of the power station) and the river upstream, with evergreen forest on the banks, 12.4064°N, 107.1780°E, 657 m a.s.l. 28.06.2018.

Figure 17. A female of Heliaeschna simplicia **at a pool under a cliff at the Phnom Tbeng northern foot clad with evergreen forest. 19.06. 2018.**

Figure 18. A male and tandem of Lestes nigriceps **at a large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.**

M4: 5.3 km S of Sen Monorom, the fast, turbid O'Romis River, with a concrete dam forming a small reservoir at a cleared damp grassy area, 12.4116°N, 107.1834°E, 672 m a.s.l. 28.06.2018.

M5: 4.7 km S of Sen Monorom, the O'Romis River valley upstream of the road, hidden in the forest, with a grassy slope with open tree stand; its tributary brook weakly flows in a low forest through a chain of pools separated with tree roots, 12.4172-4186° N, 107.1907-1937° E, 688-690 m a.s.l. 28.06.2018.

M6: a rivulet 4 km SE Sen Monorom, 'Culminicola Rivulet', Loc. 7, in Kosterin (2016: fig. 10); in 2018 mostly destroyed, with the valley now partly occupied with a pepper plantation and the forest removed; the river is somewhat dammed, slow and turbid, with a short more or less natural section with grassy banks, with tall bamboo thickets at the dammed part. 12.4453° N, 107.2203-2210° E, 692 m a.s.l. 23.06.2018.

M7: the same rivulet more downstream, rivulet 2.5 km SE Sen Monorom, flows from a concrete dam in a narrow valley through bamboo thickets; on its left bank slope there is a grassy bog with water seeping through. 12.4493°N, 107.22074°E, 682 m a.s.l., 23.06.2018.

M8: the river with the Monorom Waterfall (Loc. 4b in Kosterin 2016: fig. 8), A relatively large river with rapids and the forested left bank and partly a strip of shady forest and a road at the right bank; examined downstream of a large reservoir and upstream of the hydropower station using the energy of water flowing from the reservoir through a collateral channel. 12.442-443°N, 107.159-161°E, 610-620 m a.s.l. 23.06.2018.

M9: a rivulet near Monorom Waterfall, 'Ochracea rivulet', Loc. 4a in (Kosterin 2016). A fast rivulet 2-3 m wide, with some rapids, surrounded partly by forest patches, partly by bamboo thickets. Its valley was almost undisturbed in 2014 but in 2018 only a short natural section was left in the lowermost reaches, upstream a road with a bridge appeared, a banana plantation and a pond (see below). Most probably these changes resulted from the cessation of elephant entertainment at the waterfall. 12.4404-4421°N, 107.1608-1617°E, 631 m a.s.l. 23.06.2018.

M10: a small pond with a grassy open area and a small plantation on the above rivulet (M9), 12.4415° N, 107.1618°E, 633 m a.s.l. 23.06.2018.

M11: 3.3 km NE of Sen Monorom, a big pond with a firm bottom and the banks partly barren, partly grassy with tall bamboo thickets and forest patches and with a small grassy bog (with *Nepenthes mirabilis* (Lour.) Rafarin and *Arundina graminifloia* (D. Don) Hochr.). Scarce water hyacinth and *Salvinia cucullata* on the water surface. 12.476°N, 107.211°E, 698 m a.s.l. 22 and 24.06.2018.

M12: 15 km NNE of Sen Monorom, a large, shallow sedgy (mostly ?*Carex* sp., with participation of ?*Eleocharis* sp. and *Cyperus* sp.) swamp (Kosterin 2018b: fig. 7) situated in a broad opening of a deciduous dipterocarp forest on a narrow, moderately elevated (455 m a.s.l.) plateau. At the middle there is a long knee-deep area of open water with floating *Nymphoides* (?*indica*), and a ditch along the road. (The satellite image of 2012 at Google Earth made before the construction of the road shows the opening small and hardly traceable, suggesting existence a forest swamp at that place and subsequent logging.). 12.5771°N, 107.2587°E, 455 m a.s.l., 27.06.2018.

M13: 16 km NNE of Sen Monorom, a large, deep and broad valley with a broad stony bed (Kosterin 2018a: fig. 12), with frequent stones of a porous igneous rock, which did not correspond to a weak brook (sometimes disappearing in the ground) flowing through and connected some quite deep pools (maybe the river was dammed upstream); bamboo thickets, *Mimosa pigra* bushes, and remnants of evergreen forest at the banks. 12.584-587°N, 107.253-256°E, 400-420 m a.s.l. 26-27.06.2018.

M14: 16 km NNE of Sen Monorom, 5.3 km SE of Pou Chhrey, a dammed lake-like but long river reach, up to waist-deep, with a firm bottom, broad floating carpets of *Ipomoea aquatica* along banks and *Persicaria* sp. with white flowers emerging at shallow places. 12.588-590°N, 107.24° E, 405 m a.s.l. 27.06.2018

M15: 12-13 km NE of Sen Monorom, the ?Pulung River (Loc. 11, 'Kruegeri River', in Kosterin 2016: fig. 11), about knee-deep, fast flowing in a rocky bed through a flat terrain with open deciduous dipterocarp forest; examined between the bridge and the right tributary upstream of it. 12.5194-5221°N, 107.2907-2931°E, 529-530 m a.s.l. 25.06.2018.

M16: 12.8 km NE of Sen Monorom, lower reaches of a brook – right tributary of the above mentioned ?Pulung River (Kosterin 2018a: fig. 11). 12.5186-5221°N, 107.2931-2954°E, 529-544 m a.s.l. 25 and 27.06.2018.

M17: a brook downstream (500 m W to NW) of the Buu Sraa Waterfall ('Loringae brook'; Loc. 13a-c, in Kosterin 2016: figs 13-15). A meandering brook with partly silty and partly stony bed with rapid sections and pools, shaded by tall forest (with traces of old fire) and tall bamboo thickets, often crossed with fallen trees. There is quite high a waterfall at the upstream end of the studied section; at the mouth it crosses an open grassy gentle right bank of the main river with open tree stand, 12.5673-5724°N, 107.4139-4173°E, 416-490 m a.s.l. 24.06.2018.

Results and Discussion. The Odonata observed, collected and photographed in the above listed localities are presented in Table 2, including 87 identified species, 2 unidentified species and one, *Tetrathemis ?platyptera* Selys, 1878, provisionally identified because it is known to be common in Mondulkiri Province (Kosterin 2016), with others not reported. These 90 species have been registered in just 6.5 days. Earlier I reported from this province 106 species recorded in 10 days (ca 17% more species for ca 53% more time). One can see how the savannah-clad plateau of Mondulkiri Province is richer than the above considered Cambodian Lowland around Siem Reap (with comparable areas examined), where I found 52 species in 7 days, that is ca 43% less for about the same time. Moreover, the Phnom Kulen Plateau situated in the same Siem Reap Province and clad with evergreen forest for years of observations revealed 97

Table 2. Odonata registered in Mondulkiri Province (locs M1-M16, see the text) on June 22-28, 2018. Codes of abundance: - – not found, 1 – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals, of any sex), 3 - moderately abundant (6-20), 4 – abundant (~20-100); **underlining indicates that some specimen(s) was (were) collected at this locality, boldface – that the species was photographed in nature**; **other registrations are sightings.**

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
Calopterygidae																	
1. *Neurobasis chinensis*	-	-	1♀	-	-	1♂	-	-	2	-	3	-	3	-	-	-	-
2. *Vestalis gracilis*	-	2	-	2	-	2	2	-	4	-	3	-	2	1	-	3	3
Epallagidae																	
3. *Euphaea inouei*	-	1♂	-	2	1♂	-	-	4	4	-	-	-	**4 (Fig. 20a)**	-	2	**3 (Fig. 20b)**	**4 (Fig. 19)**
4. *Euphaea sanguinea*	-	-	-	-	-	-	2	2	3	-	-	-	-	-	-	-	-
Chlorocyphidae																	
5. *Aristocypha fulgipennis*	-	-	3	-	-	-	-	1♂	-	-	-	-	-	-	-	2	3
6. *Libellago lineata*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
7. *Heliocypha biforata*	-	-	-	2	-	-	-	3	-	-	-	-	3	-	-	3	3
8. *Heliocypha perforata limbata*	-	-	-	-	-	-	-	3	-	-	-	-	**2**	-	2	-	3
Phylosinidae																	
9. *Rhinagrion hainanense*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Lestidae																	
10. *Lestes nigriceps*	-	-	-	-	-	-	-	-	-	-	-	**4 (Fig. 18)**	-	-	-	-	-
11. *Lestes praemorsus decipiens*	-	-	-	-	-	-	-	-	-	-	-	**4 (Fig. 21)**	-	-	-	-	-
Coenagrionidae																	
12. *Aciagrion approximans*	2	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-
13. *Agriocnemis nana*	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-
14. *Argiocnemis rubescens rubeola*	-	-	-	-	-	-	-	-	-	-	-	**2 (Fig. 22a)**	-	2	-	-	-
15. *Ceriagrion auranticum*	-	-	-	-	-	1♂	-	-	-	-	-	2	-	-	-	-	-
16. *Ceriagrion azureum*	-	-	-	-	-	-	-	-	-	-		1♀	-	-	-	-	-
17. *Ceriagrion cerinorubellum*	-	-	-	-	-	-	-	-	-	-	1♀	1♀	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
18. *Ceriagrion indochinense*	1♂	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-
19. *Ischnura senegalensis*	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-
20. *Mortonagrion aborense*	3	-	-	-	-	-	-	1♂	1♂	-	-	-	-	-	-	-	-
21. *Pseudagrion australasiae*	-	-	-	-	-	-	-	-	-	-	1♂	1♂	-	3	-	-	-
22. *Pseudagrion microcephalum*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
23. *Pseudagrion pruinosum*	-	-	-	-	-	1♂	1♂	-	-	-	-	-	-	-	-	-	-
24. *Pseudagrion rubriceps*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
Platycnemididae																	
25. *Coeliccia poungyi dasha*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
26. *Coeliccia rolandorum*	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-	2
27. *Copera marginipes*	2	2	-	2	-	3	-	1♂	1♂	-	-	-	3	3	1♂	2	2
28. *Pseudocopera ciliata*	1♀	-	-	-	-	1♂	-	-	-	-	4	-	-	-	1♀	-	-
29. *Prodasineura autumnalis*	-	-	2	2	-	-	-	4	4	-	-	-	3	3	3	3	3
30. *Prodasineura doisuthepensis*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
31. *Prodasineura* sp., *verticalis* sensu Asahina, 1984	2	3	-	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-
Platystictidae																	
32. *Protosticta* cf. *caroli*	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-	2
Aeshnidae																	
33. *Anax guttatus*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	
34. *Gynacantha subinterrupta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♀
35. *Tetracanthagyna waterhousei*	-	-	-	-	-	-	-	-	-	-	-	-	1♀ (Fig. 23)	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
Gomphidae																	
36. *Asiagomphus reinhardti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2 (Figs 24-25)**
37. *Burmagomphus asahinai*	-	-	-	-	-	-	-	-	**1♂**	-	-	-	-	-	-	-	-
38. *Burmagomphus divaricatus*	-	-	-	-	1♂	-	-	-	1♂	1♀	-	-	-	-	-	-	-
39. *Euthygomphus schorri*	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	-
40. *Euthygomphus yunnanensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂
41. *Gomphidia* sp.	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	2	-	-
42. *Gomphidictinus perakensis*	-	-	-	-	-	-	-	-	**1♂**	-	-	-	-	-	-	2	**3**
43. *Ictinogomphus decoratus melaenops.*	-	-	-	-	-	-	-	-	-	2	-	1♂	2	3	-	-	-
44. *Lamelligomphus castor*	-	-	-	-	-	-	-	-	1♂	-	-	-	2	-	-	**2 (Fig 26)**	3
45. *Macrogomphus kerri*	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	-	**1♂**
46. *Microgomphus alani*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1♂	-
Macromiidae																	
47. *Epophthalmia frontalis*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
48. *Macromia flavocolorata*	-	-	-	-	-	-	-	-	**3 (Figs 27-28)**	-	-	-	-	-	-	-	-
49. Gen. sp.	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-	-
Synthemistidade																	
50. *Idionyx thailandica*	-	1♂	-	-	2	-	-	-	-	-	-	-	1♀	-	-	2	**3 (Fig. 29)**
51. *Macromidia genialis buusraaensis*	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	2	-
52. *Macromidia rapida*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2**	2
Libellulidae																	
53. *Acisoma panorpoides*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
54. *Aethriamanta gracilis*	-	-	-	-	-	-	-	-	-	1♂	-	**1♂**	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
55. *Brachythemis contaminata*	-	-	-	-	-	3	3	-	-	2	3	2	-	2	-	-	-
56. *Brachydiplax chalybea*	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-
57. *Brachydiplax farinosa*	-	-	-	-	-	2	-	-	-	-	-	**3**	-	3	-	-	-
58. *Cratilla lineata calverti*	-	-	-	-	-	-	-	-	-	-	-	-	1♀	-	-	-	-
59. *Crocothemis servilia*	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-
60. *Diplacodes nebulosa*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
61. *Diplacodes trivialis*	-	-	-	-	-	-	1♀	-	-	-	-	3	1♂	-	-	-	-
62. *Hydrobasileus croceus*	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-	-
63. *Indothemis carnatica*	-	-	-	-	-	-	-	-	-	-	-	**3 (Fig. 30a-b)**	-	-	-	-	-
64. *Indothemis limbata*	-	-	-	-	-	-	-	-	-	-	-	**3 (Figs 21, 30c)**	-	-	-	-	-
65. *Neurothemis fluctuans*	-	-	-	2	-	4	3	-	-	-	-	1♂	-	-	2	-	-
66. *Neurothemis fulvia*	-	-	-	-	-	-	-	-	1♂	-	-	1♂	2	2	-	-	1♂
67. *Neurothemis intermedia atalanta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
68. *Onychothemis culminicola*	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-
69. *Onychothemis testacea*	-	-	-	-	-	-	-	1♂	2	-	-	-	-	-	2	-	2
70. *Orthetrum chrysis*	-	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-
71. *Orthetrum luzonicum*	-	1♂	-	**2 (Fig. 31)**	-	**2**	-	-	-	1♂	**1♂**	-	-	-	-	-	-
72. *Orthetrum neglectum*	-	-	-	1♂	-	-	-	-	1♂	-	-	1♂	1♂	-	**1♂**	-	-
73. *Orthetrum glaucum*	-	-	-	**2**	-	-	-	-	1♂	-	-	-	-	-	-	-	-
74. *Orthetrum sabina*	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-
75. *Orthetrum triangulare*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂
76. *Palpopleura sexmaculata*	-	-	-	**1♀**	-	-	1♂	-	-	-	1♂	-	-	-	-	-	-
77. *Pantala flavescens*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Localities	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17
78. *Potamarcha congener*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
79. *Pseudothemis jorina*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
80. *Rhyothemis phyllis*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
81. *Rhyothemis plutonia*	-	-	-	-	-	-	-	-	-	2	-	-	2	3	-	-	-
82. *Rhyothemis triangularis*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
83. *Tetrathemis* sp. (?*platyptera*)	-	-	-	-	1♂	-	-	-	1♂	-	-	-	-	-	-	-	-
84. *Tholymis tillarga*	-	-	-	-	-	2	-	-	-	-	3	-	-	-	-	-	-
85. *Trameа transmarina euryale*	-	-	-	-	-	-	-	-	-	-	-	**3 (Fig. 32)**	-	-	2	-	-
86. *Trithemis aurora*	-	-	-	-	-	-	-	-	-	2	4	4	4	4	2	2	-
87. *Trithemis festiva*	-	1♀	-	2	-	2	-	-	-	-	-	-	3	-	-	-	-
88. *Urothemis signata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	-
89. *Zygonyx iris malayana*	-	-	-	1♂	-	-	-	3	2	-	-	-	3	-	3	-	2
90. *Zyxomma petiolatum*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

species that is a comparable to 90 species found in Mondulkiri Province in 6.5 days.

The richest place was the swamp of M12, not studied before, which offered 30 species for two hours of examination. (*Trithemis festiva* (Rambur, 1842) was mentioned for this place in (Kosterin 2018b) in error.)

Macromia flavocolorata Fraser, 1922 (Figs 27-28) is a new country record for Cambodia. The species for the first time found in Mondulkiri Province and not included in its preliminary checklist (Kosterin 2016) are *Lestes nigriceps* Fraser, 1924 (Fig. 18), *Diplacodes nebulosa* (Fabricius, 1793), *Indothemis carnatica* (Fabricius, 1798) (Fig. 30a-b), *I. limbata* (Selys, 1891) (Figs 21, 20c), all found in the swamp of M12 and already mentioned in (Kosterin 2018b). Note changes in taxonomic treatment/identification of some species accepted in this paper (Table 2) as compared to Kosterin (2016): *Euphaea inouei* Asahina, 1977 (Figs 19-20) for *E. masoni* inouei; *Euphaea sanguinea* Phan, Kompier, Karube et Hayashi, 2018 for '*E. ochracea*' (Phan et al. 2018), *Microgomphus alani* for the misidentifications '*Microgomphus jurzitzai*' and '*Heliogomphus* sp. cf. *svihleri*' (Kosterin 2019); *Macromidia genialis buusraaensis* for *M. genialis* ssp. (Kosterin 2018a).

Remarks. 1. In 2018 I managed to collect a topotypical male (Figs 24) and female (Fig. 25) of *Asiagomphus reinhardti* Kosterin et Yokoi, 2016 in its type locality, which is M17 ('Loringae brook'). The original description was based on the holotype male from that place collected in 2014 and

Figure 19. Males of Euphaea inouei **at the 'Loringae brook' downstream of the Buu Sraa Waterfall (M17). 24.06.2018.**

Figure 20. A female (a; M13; 26.06.2018) and copula (b; M16; 25.06.2018) of Euphaea inouei**.**

a paratype male from Laos, Champsak Province, Paksong (Kosterin & Yokoi 2016). These two specimens differed in presence (the holotype) versus absence (the paratype) of the antehumeral stripes and the yellow markings on the metepisternum and the size of the lateral yellow spots on S8 (considerable in the holotype versus tiny in the paratype). The characters of the newly obtained topotypical male (Figs 24b) was as in the holotype, with the mentioned yellow markings a bit smaller.

Figure 21. Males of Lestes praemorsus decipiens **and** Indothemis limbata **the large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.**

Figure 22. Young male (a; M12, 27.06.2018) and female (b; OS2; 21.03.2019) of Argiocnemis rubescens rubeola.

Figure 23. A female of Tetracanthagyna waterhousei **from the river 16 km NNE of Sen Monorom (M13). 27.06.2018.**

Figure 24. A topotypical male of Asiagomphus reinhardti **in nature in the species' type locality, the 'Loringae brook' downstream of Buu Sraa Waterfall (M17). 24.06.2018.**

Figure 25. The topotypical female of Asiagomphus reinhardti **(from M17). 24.06.2018.**

Figure 26. Males of Lamelligomphus castor **from the right tributary of the ?Pulung River (M16). 25.06.2018.**

Figure 27. A male of Macromia flavocolorata **from the 'Ochracea rivulet' (M9), a left tributary of the river with the Monorom Waterfall. 23.06.2018.**

The female sex of this species was later described by Kompier (2018) from three females from Vietnam, one from Bao Loc Province (southern Vietnam) and two from Gia Lai Province (central Vietnam). He provided the following diagnosis for the *A. reinhardti* female: "Structurally the most prominent is the lack of the connection between the ridge that connects the lateral ocelli and the margin of the compound eyes. ... Other features that support the identification are the yellow lines along the anterior margin of 8 and the longitudinal mid-dorsal line over S10" (Kompier 2018: 322). The topotypical female (Fig. 25) shows the two former characters but not the last, as having S10 completely black. The three Vietnamese female specimens showed considerable variation with respect to the maculation of the labrum, mesepisternum, metepisternum, S2 and S10, the colour of the cerci and also the expression of the spikes between the lateral ocelli and eye margin and the knob of the occipital plate (Kompier 2018). The topotypical female (Fig. 25) has two small yellow spots at the base of labrum; antehumeral streaks in the upper half of the mesepisternum; the metepisternum

Figure 28. A female of Macromia flavocolorata **from the 'Ochracea rivulet' (M9), a left tributary of the river with the Monorom Waterfall. 23.06.2018.**

Figure 29. A male of Idionyx thailandica **under the forest canopy over the 'Loringae brook' downstream of Buu Sraa Waterfall (M17) at the end of the day of 24.06.2018.**

with a large yellow spot behind the spiracle and a continuous yellow stripe above it, which is composed of two large bulges at its lower and upper ends and a very narrow central part; S8 with small lateral yellow spots; the cerci yellowish above and brownish elsewhere. The central occipital knob is much smaller than illustrated by Kompier (2018: fig. 9f), and there is a trace of a lateral knob at the middle of the left side of the occipital plate margin; the 'spikes' (actually blunt, squarish-rounded processes) dorsolaterad of the lateral ocelli as illustrated (Ibid.). Hind wing 38 mm, abdomen 43.5 mm. These characters, except for the absence of S10 yellow marking, are within the variation described for the three Vietnamese females by Kompier (2018).

Two males of *A. reinhardti* were met in the type locality on 24.06.2018 at the same place as the holotype on 15.06.2014: about the middle of the 'Loringae brook' reach between its waterfall and the mouth, surrounded by tall evergreen forest. Both perched on boulders or logs (Fig. 24b) at the stream (the holotype did the same, see Kosterin & Yokoi 2016: fig. 1), when startled one of them relocated to a leaf at ca 2 m above the ground (Fig. 24a). A female was found in the same place while hovering above the water (it differed at distance from *Lamelligomphus castor* Lieftinck, 1941, which is fond of hovering, in having more yellow and a club-shaped abdomen).

2. Of the two collected males of *Burmagomphus divaricatus* Lieftinck, 1964 one had no additional denticles on the posterior hamulus, as in the original description (Lieftinck 1964) while the other had two additional denticles. This character is variable in this species in Cambodia (Kosterin 2014; 2016; 2020b).

3. Unlike a number of Cambodian populations of *Idionyx thailandica* Hämäläinen, 1985 elsewhere, e.g. in Ratanakiri Province (Kosterin 2014) or the Phnom Kulen Mts. (Kosterin 2020b), that in Mondulkiri Province did not exhibit shortage of males: of 9 specimens collected in 2018, 6 were males (Fig. 29); together with 5 specimens collected in 2014 (Kosterin 2016) this counts 8 males vs 6 females.

4. *I. carnatica* (Fig. 30a-b) and *I. limbata* (Figs 21, 30c) occurred together at the swamp of M12. The males were equally numerous and very active (*I. limbata* seemingly less cautious); copulae and ovipositing females were also seen. The collected specimens of *I. carnatica* (3 ♂♂) and *I. limbata* (1 ♂, 1 ♀) differ as follows: (i) the male appendages are brownish in the former and black in the latter; (ii) there are 9 ½ fore wing antenodals of the former and 11 ½ in the latter (both sexes); (iii) the former is slightly larger (hindwing 30 mm in the male and 32.5 mm in the female, abdomen without appendages 24-24.5 mm,

Figure 30. Males of Indothemis carnatica **(a-b) and** Indothemis limbata **(c) at the large grassy swamp 15 km NNE of Sen Monorom (M12). 27.06.2018.**

versus hindwing 28-28.5 mm and abdomen 22-23 mm in *I. limbata*). These differences rather correspond to those given by Fraser (1936) but for *I. carnatica* (as *Indothemis caesia* (Rambur, 1842)) he stated dull-ochreous appendages and 8 ½ antenodals (versus 10 ½ - 12 ½ for *I. limbata*). In the collected males of *I. limbata*, the dark rims of the wingtips, also considered by Fraser as a specific character, are very narrow in two males (Figs 21, 30c) and absent in the third one. The living males of *I. limbata* (all which I saw in Cambodia) have a bright blue spot while Fraser (1936: 341), maybe based on collected specimens, mentioned only "purplish-steely reflex".

Observations. 1. *E. sanguinea* always perched in shade and rarely flew, while *E. inouei* perched both in shade and sun and was much more active.

2. *M. flavocolorata* (Figs 27-28) were found to be remarkably confined to a specific place at the 'Ochracea rivulet' valley (M9) 66 m from its mouth: a tiny lateral brook, situated under a slope disturbed by an excavator (12.44165°N, 107.16108 E). It was just several metres long, shady and sluggish, with sucking bottom of red mud formed by a ground washed down from that disturbed slope, with sparse *Cyperus* sp. I was there

Figure 31. A copula of Orthetrum luzonicum **at a damp meadow near a dam at the O'Romis River (M4). 28.06.2018.**

since 9:40 to 10:00 a.m. First a female appeared which started to fly to and fro very low and for very short distance not more than 1 m; when I caught, it another one appeared in the same place almost immediately. After I caught it as well, several males appeared at the same place one after another, which ranged faster, higher (ca 1 m high), and for a larger distance of 2-3 m. I caught three males but I often missed strokes so more males appeared in fact. Besides, above the same place not less than two males of *Zygonyx iris malayana* Laidlaw, 1902 appeared, a male of *Onychothemis culminicola* Förster, 1904, a male of *Orthetrum neglectum* (Burmeister, 1839) and a male of *B. divaricatus* sat on the mud. Some males of *M. flavocolorata* appeared at a bit more upstream place of this brook, without mud; there I caught also a male of *Macrogomphus kerri* Fraser, 1922. When I revisited this place at ca 13:30 p.m. I did not see any of the above species but collected a male of *Euthygomphus schorri* Kosterin, 2016 and saw a male of *Neurothemis fulvia* (Drury, 1772). I had no idea why this tiny strip

Figure 32. A male of Trameа transmarina euryale **at the large grassy swamp 15 km NNE of Sen Monorom (M 12). 27.06.2018.**

of shaded mud from a disturbed slope of an otherwise natural woody valley attracted so many diverse dragonflies in the morning; I did not observe anything like this elsewhere. This especially concerned *M. flavocolorata*, both sexes of which apparently formed a queue to fly over it. In Koh Kong Province I observed males of *Macromia septima* Martin, 1904 to range along an open river bank with disturbed ground (Kosterin 2014).

3. Earlier I supposed that in Mondulkiri Province, *Onychothemis culminicola* and *O. testacea* Laidlaw, 1902 tend to exclude each other since I did not observe them together (Kosterin 2016). This was not the case in 2018 when I observed both species together at the river with Monorom Waterfall (M8) and its tributary 'Ochracea rivulet' (M9) on 23.06.2018.

Figure 33. Banana plantations penetrating into evergreen forest ca 8 km SSW of O'Som village. 21.03.2019. Photo by a local guide.

IV. O'Som vicinities

O'Som (Veal Veang District, Pursat Province) used to be a desolate village surrounded by vast evergreen rainforest and situated on very gentle, moderately elevated (400-600 m a.s.l.) sandstone terrain, actually a low plateau, being part of the Cardamom Mts. Until the end of 1990s it was one of the last strongholds of Khmer Rouge, so that for long it was hardly accessible by a muddy road crossing the Cardamoms. Everything has changed recently. A good road from Koh Kong City to O'Som was constructed to serve to several hydropower stations constructed by Chinese firms, with accompanying small towns, tall dams and vast water reservoirs with partly cleared, partly dead forest at lifeless banks. The largest one, some 6×7 km, is situated north of O'Som. The last patches of rainforest had been just cut and were still burning when I visited the village on March 20-21, 2019. The area is now occupied by young plantations among burned stumps and trunks of what recently was a vibrant forest. Yet there is one of the few remaining population of the Siamese Crocodile (*Crocodylus siamensis* Schneider, 1801) at a forested river in not far from O'Som, attracting a lot of tourists. Curiously, the nearly pristine rainforest still exists in most of the more southerly Koh Kong Province, and it is the Pursat Province territory which is dramatically devastated. The scarcely disturbed evergreen forest is retained along the Koh Kong Province border, some 6–13 km S of O'Som, which was a target of my day long trip of 21.03.2019. This was a gentle hilly terrain clad with continuous forest with a big rapidous river over a sandstone bed, dark slimy forest brooks and banana plantations under tall trees (Fig. 33) remained from the forest at its border.

Localities and Odonata therein:

OS1: 6 km SE of O'Som village, a rivulet with scarce forest remnants after fresh logging; young plantations around. 12.034°N, 103.233°E, 519 m a.s.l., 20.03.2019, ca 1:30 p.m., partly cloudy before thunderstorm. Many: *V. gracilis*, *P. rubriceps* Selys, 1876; several: *Heliocypha biforata* (Selys, 1859); few: *Copera vittata* (Selys, 1863) (1 ♂ seen), *Prodasineura autumnalis* (Fraser, 1922) (1 ♂ collected), *P. verticalis* sensu Asahina, 1984 (1 copula collected, 1 more ♂ seen), *N. fluctuans* (1 ♀ seen). A big male of Macromiidae indet. (perhaps *Epophthalmia* sp. but not *E. frontalis* Selys, 1871 since black rather than reddish), ranged over a brook flowing through a sucking ashy ground left from the burnt out forest. A female of seemingly the same species oviposited while ranging very fast above a short stretch of this brook; then in a very small pool among dry branches. The males appeared twice but I missed a net stroke; the female also appeared twice and I managed to hit it with the net but it fell onto the water and managed to fly away. So sad losses of unidentified dragonflies from an interesting family, which exhibited reproductive behaviour at their already killed habitat and surely no more exist there.

OS2: 9 km SSW of O'Som village, a sluggish brook in a shady valley hard to penetrate into and hidden in primary evergreen forest, the water flowed well in the morning but almost disappeared in the afternoon. 11.999°N, 103.188°E, 479 m a.s.l. 21.03.2019. Very many: *V. gracilis*; many: *C. vittata* (mature and at the ghost stage, 1 ♀ collected); several: *H. biforata, Rhinagrion viridatum* Fraser, 1938 (3 ♂♂ seen, 1 collected), *Or-*

thetrum chrysis (Selys, 1891); singular: *Coeliccia kazukoae* Asahina. 1894 (1 ♂ released), *Orchithemis. pulcherrima* Brauer, 1878 (♂ collected). At the open place where the brook crossed the road there were *N. fulvia* and *N. tullia* (Drury, 1773) (1 ♂ of each) and a very cautious male of *Macrogomphus kerri* (poorly photographed) perched on thin branches at the road. Further along the shady poor road through the forest many *V. gracilis* and *Cratilla lineata calverti* Förster, 1903 occurred, and three females of *R. rubescens rubeola* Selys, 1877 (Fig. 22b) (collected) were unexpectedly found in low and sparse herbage (Fig. 22b), two of which resting on neighbouring stems.

OS3: 12.5 km SSW of O'Som village, a big rapidous river in a broad sandstone bed flowing through primary evergreen forest, 11.972°N, 103.180°E, 413 m a.s.l. 21.03.2019. At the river sunny banks there were many: *Neurobasis chinensis* (Linnaeus, 1758), *Zygonyx iris malayana*, *Heliocypha perforata limbata* (1 ♂ collected); several: *P. rubriceps* (3 ♂♂ seen), *P. autumnalis*; singular – *H. biforata*, *Dysphaea gloriosa* Fraser, 1928, *Euphaea masoni* Selys, 1859, *T. aurora* (Brauer, 1865) (1 ♂ of each seen); in shade many *V. gracilis* and *C. vittata*.

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