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Update of 2017-2018 to Odonata of Kampong Saom Peninsula, Cambodia

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Abstract

New data on Odonata of the Preah Sihanouk Province of Cambodia obtained in March 2017 and November 2018 are presented. The presence of *Onychargia atrocyana* Selys, 1865 in Cambodia is confirmed. Twenty-one species are added to the known fauna of the Kbal Chhay Waterfall environs, 19 species to that of Ream Peninsula and 4 to that of Koh Rong Island. The total number of species registered for Kampong Saom Peninsula amounts to 74. The presented data are rather of historical importance since most of the remaining forest has been quickly and irreversibly logged a few months ago. The validity of *Gynacantha demeter* Ris, 1911 as a species distinct from *G. dohrnii* Krüger, 1899 is doubted..

Key words: Odonata, dragonflies, damselflies, fauna, Cambodia, Preah Sihanouk Province, Kampong Saom Peninsula, Ream Peninsula, nature extermination, national Preah Sihanouk Ream National Park, *Gynacantha demeter* Ris, 1911; *Gynacantha* dohrni Krüger, 1899

Introduction

Earlier I published results of my previous odonatological excursions to Preah Sihanouk Province in April 2010 (Kosterin 2010), May 2013 (Kosterin 2014) and April 2015 (Kosterin 2015a). Additional trips in March 2017 and November 2018 provided some further findings which are presented here.

Kampong Saom Peninsula (with a second order Ream Peninsula at its south-east) is a low hilly projection of the Cardamom mountain range into the Gulf of Siam of the South China Sea. There is the large and well-known city: Sihanoukville (formerly Kampong Saom). The hills are formed by sandstone. The terrain is generally covered with evergreen tropical forests but the immediate surroundings of Sihanoukville are largely deforested, as soon will be the rest.

Ream Peninsula (ca 14 x 6 km) is a part of Kampong Saom Peninsula, situated 14 to 26 km SE of Sihanoukville and harbouring the Ream National Park. It has a ridge called Phnom Mollou (277 m a.s.l.) along its NW bank, which has a rather steep western slope and a very gentle slope towards the eastern flat part of the peninsula; there is also a hill 149 m a.s.l. in the north-eastern part called 'Peak Lingam'. A roadside billboard at the 'Turtle Stone' says that in 1st century BC, Prince Huntian travelled across

the ocean riding a God Turtle who pointed at Ream, the Prince landed, conquered Ream Land, married Princess Lui Yu, a leader of the Ream tribe, and founded Funan, the first Cambodian kingdom (seemingly a local version of the Funan origin legend). A large part of the Ream Peninsula is still formally considered as occupied by Preah Sihanouk Ream National Park embracing both the hills and a coastal lowland, until present covered with thick coastal lowland evergreen forest. In the recent decade, however, the park suffered from local cuttings and construction of resorts, casinos and broad roads inside it but still remained a large massif of contiguous forest. In early November 2018, I witnessed total logging and burning of the forest throughout the park (Fig. 1). For some (perhaps formal) reason solitary trees, but not forest patches, were left. At the time of my visit the logging area ended in a distance of ca. 50 m from the remarkable Big Tree of Ream, ca. 2,000 years old and 50 m tall. In some places young banana and coconut trees were already planted among burned stumps. This was rather surprising as the serious forces involved in this national park murder would hardly be interested in such an unprofitable land use; perhaps that was just an accompanying activity of locals.

Figure 1. Forest logging in Preah Sihanouk Ream National Park, 10.11.2018.

This was said to result from some Chinese concession, but no detail is known to me. According to Wikipedia (accessed on 7.02.2019), "in 2011, lawmakers issued a 'law update' on Ream and other protected areas, stating: "The land area of 84.5 ha (209 acres) of the Ream National Park Zone shall be determined as a community area located in Ream commune, Prey Nub district of Preah Sihanouk province." That area is less than 1 km^2, while according to my rough estimation, in November 2018 the forest had already been completely logged on not less than 15-20 km^2. This happened even in the vicinity of the once brilliant coast with the Golden Silver Gulf Resort, advertised as 'heaven on earth' when the project of its construction inside the national park was pushed through government several years ago and inspired protests (Pie & Titthara 2014). As compared to the present disastrous situation this seems to be a small, relatively almost harmless incident. The touristic value of this place seems to be sacrificed in favour of interests recognising neither existence of nature nor national interests. No doubt the land will soon become as empty, dry and barren as the neighbouring Sihanoukville surroundings.

The picturesque Kbal Chhay Waterfall (Fig. 2) is a popular recreation place where the Cambodian thriller 'The Snake King's Child' (2001) was filmed. It retained a large massif of the forest around, disturbed by two very large (2.9 x 2.4 and 1.9 x 0.8 km), ramified water reservoirs (seemingly filled in the 2000s) and for several years furiously logged immediately NE of the waterfall but until recently intact SE of it, downstream the main Prek Teuk Sap River. In November 2018 the forest was logged and burnt also there, at the right river bank 1.5 km SE of the waterfall, with ash descending from the sky to the area I was examining.

Figure 2. Kbal Chhay Waterfall (locality KC1) at dry season, 10.03.2017.

There are several hilly islands near the Kampong Saom Peninsula, the largest of which are Koh Rong and Koh Rong Samloem, both hilly and covered with evergreen forest. I visited Koh Rong in 2015 to find it a pristine gem in an unimaginably crystal-clear sea. In 2017, I revisited Koh Rong for three days in the same late dry season, but the situation had deteriorated dramatically. Plans to 'develop' the thinly populated SW part of the island raised protests of the local community which managed to force the government to divide the land between the locals. To fix their right they had to 'explore' the land somehow so they, solely to demonstrate this, cut and burnt the understorey leaving the tall trees of once vibrant forest covering the SW part of the island. Its remnants at the southern coastal slope became nearly lifeless, and only small patches of intact forest could be found on the central ridge. The forest of the steeper northern coast facing Long Beach was not burnt but cut through by construction of broad roads and some villas.

The first draft of this paper was prepared in spring 2018 but had to be rewritten because of the extermination of habitats witnessed in November. Hence, the below presented data on Odonata from that lowland evergreen tropical forest paradise of the so recent past had turned to be of rather a historical nature still before they were published.

Methods

Odonata were sought while walking along brooks, rivulets and swamps. Common species were recorded by sight, small series of some species were collected. Odonata were photographed free in purely natural conditions, never posed, using Olympus Camedia C8080 and Canon EOS 350D cameras with a Sigma AF 24-70 mm F2.8 EX DG MACRO lens. Coordinates were recorded by Garmin eTrex H personal GPS navigator but the provided ranges for the areas actually examined, as well as elevations above sea level, were revised using Google Earth. The dates are provided in the dd.mm.year format.

New species described

Two species collected in the area considered have recently been described as new to science: *Amphicnemis valentini* (Kosterin & Kompier 2018) from the Ream Peninsula (collected in 2017) and *Euphaea cyanopogon* Hämäläinen, Kosterin et Kompier, 2019 (Kosterin & Kompier 2018; Hämäläinen et al. 2019) from Kbal Chhay Waterfall (collected in 2010, 2017 and 2018). The type series of these two species also contain paratypes from the Vietnamese Phú Quốc Island, which represents the south-westernmost part of the Cardamom Ecoregion and is close to the Cambodian Kampong Saom Peninsula.

New data from the Kbal Chhay Waterfall area

Kbal Chhay Waterfall is situated on a plain covered with evergreen forest that is rapidly being exterminated. This place was briefly examined by me on 19.04.2010 (Kosterin 2010) and more thoroughly on 26 - 27.05.2013 (Kosterin 2014); for a more detailed description of the site see the latter source. Now I revisited it on 6 and 10.03.2017 and

9.11.2018. The majority of type specimens of *E. cyanopogon* were collected there. Also, some species were met which I did not find there before. The data for seven localities at Kbal Chhay area for all the five visits are summarised in Table 1 in appendix; the localities are as follows:

KC1. The waterfall (Fig. 2) and the river below it; pools at flat rocks and in shady sides of the valley. 10.6744-6751 N 103.6086-6097 E, 40-46 m a.s.l. 26-27.05.2013 (Kosterin 2014), 6 and 10.03.2017 and 9.11.2018 (this paper).

KC2. The Prek Teuk Sap River upstream the waterfall: broad, calm, rather shallow, with banks overgrown with trees and *Pandanus* sp.; flat sandstone rocks at the waterfall. 10.6734-6744 N 103.6070-6086 E, 49-52 m a.s.l. 26-27.05.2013 (Kosterin 2014), 6.03.2017 (briefly in dusk), 10.03.2017 (briefly at midday) (this paper).

KC3. A small left tributary of the main river just upstream the waterfall; the lowermost reaches open, upstream the rivulet hidden among *Pandanus* sp. and trees. A secondary forest, with a forked fern layer, nearby. 10.6755-6782 N 103.6085-6090 E, 48-55 m a.s.l. 19.04.2010 (Kosterin 2010), 26.05.2013 (only *V. gracilis* found) (Kosterin 2014), 6 and 10.03.2017 (this paper).

KC4. 'Fluviatilis pond' of Kosterin (2014: fig. 28), 26.05.2013. In 2017 it had already disappeared and was not examined.

KC5. The Prek Teuk Sap River downstream the waterfall, 1-1.5 km SE of it: alternating fast parts at flat rocks and broad calm reaches and arms of variable depth (Fig. 3). The right bank faces evergreen forest, being logged and burnt in November 2018, a stripe of the same on the left bank separating it from small old farms. Some *Pandanus* sp. at both banks (Fig. 3 below; Kosterin 2014: fig. 27). 10.6675-6703 N, 103.6183-6227 E, 11-16 m a.s.l. 26-27.05.2013 (Kosterin 2014), 6 and 10.03.2017 and 9.11.2018 (this paper).

KC6. The E bank of the second (on the road from the Waterfall) bay of the upper (larger, 2.9 x 2.4 km) water reservoir, with evergreen forest, 3 km SW of Kbal Chhay. 'Epophthalmia Reserve' of Kosterin (2014). On 26.05.2013 examined at 10.661-662 N, 103.603-606 E; there was also much less water than now, so the banks were broadly barren (see Kosterin 2014). Most interesting was a grassy roadside pool (a former ground pit) at 10.651 N, 103.596 E, 68-69 m which was just a wet place on 10.03.2017 (Fig. 4) but waist-deep on 9.11.2018 (this paper).

KC7. The NE bank of the lower (smaller, 1.9 x 0.8 km) water reservoir, with a broad zone of barren banks with dead tree trunks and weak grass; apart an evergreen forest margin rimmed with a forked fern zone, 10.648-655 N, 103.578-579 E, 72-78 m 3.3 km SW of Kbal Chhay Waterfall. 'Dead Rivulet' of Kosterin (2014). 26.05.2013 (there was much less water than now) (Kosterin 2014) and 6.03.2017 (briefly; this paper).

Herewith twenty-one species are added to the known fauna of the Kbal Chhay environs, one of them, *E. cyanopogon*, was even described as new with its type locality here (Hämäläinen et al. 2019), although in fact had been know from this place before as unidentified, misidentified and under another name (Kosterin 2010; Kosterin et al. 2012; Phan et al. 2018; for the review see Hämäläinen et al. 2019). Additional unpublished photos in its natural habitat below the waterfall are shown in Fig. 5. The species was not at all seen at the Prek Teuk Sap River 1-1.5 km downstream of the waterfall (KC5) in

Figure 3. The Prek Teuk Sap River 1 km downstream Kbal Chhay Waterfall (locality KC5), 6.03.2017.

May 2013 and March 2017 while it was found there even more abundant than at the waterfall itself in November 2018. At that time, teneral specimens occurred at both KC1 (Fig. 5a) and KC5.

Figure 4. A shallow roadside grassy swamp at a water reservoir 3.3 km SW Kbal Chhay Waterfall (locality KC7), 10.03.2017.

The other species new for the site (in a broad sense) are *Heliocypha biforata* (Selys, 1859), *Aciagrion borneense* Ris, 1911, *Agriocnemis minima* Selys, 1877, *A. nana* (Laidlaw, 1914), *A. pygmaea* (Rambur, 1842), *Archibasis viola* Lieftinck, 1949, *Ceriagrion olivaceum* Laidlaw, 1914, *Copera vittata* (Selys, 1853), *Prodasineura autumnalis* (Fraser, 1922), *Gynacantha subinterrupta* Rambur, 1842, *Brachygonia oculata* (Brauer, 1878), *Diplacodes nebulosa* (Fabricius, 1793), *D. trivialis* (Rambur, 1842), *Neurothemis fulvia* (Drury, 1773), *Orthetrum glaucum* (Brauer, 1865) (Fig. 6), *O. neglectum* (Rambur, 1842), *Pantala flavescens* (Fabricius, 1798), *Potamarcha congener* (Rambur, 1842), *Rhodothemis rufa* (Rambur, 1842), *Trithemis festiva* (Rambur, 1842), *Zygonyx iris malayanum* (Laidlaw, 1902), *Zyxomma petiolatum* Rambur, 1842. One more species, Nannophya *pygmaea* Rambur, 1842, was registered at KC3 in early August 2011 by François Mey (pers. comm.). So, the total number of species known to the site reached 53. More than half of them, 32, are most easily found libellulids, so the fauna of the place is obviously still understudied. No doubt more will be found in future; first of all some most common lotic species, such as *Ischnura senegalensis* (Rambur, 1842), *Crocothemis servilia* (Drury, 1770) etc., should be present in vast water reservoires (constructed for the water supply of Sihanoukville) which were only briefly examined. The unidentified gomphid mentioned in Table 1, of a size of *Gomphidia* sp. or slightly less, was twice observed at the sunny midday of 6.03.2017 perching ca. 2 m high on tall *Pandanus* sp. near fast shallow river reaches on a broad sandstone bed. *Epophthalmia* sp. seems to be a common species in this area breeding in the vast water reservoirs, as numerous exuviae were found at one of those in 2013 (Kosterin 2014), but until present I failed to catch for identification any of the individuals observed broadly ranging over the Prek Teuk Sap River on each visit there.

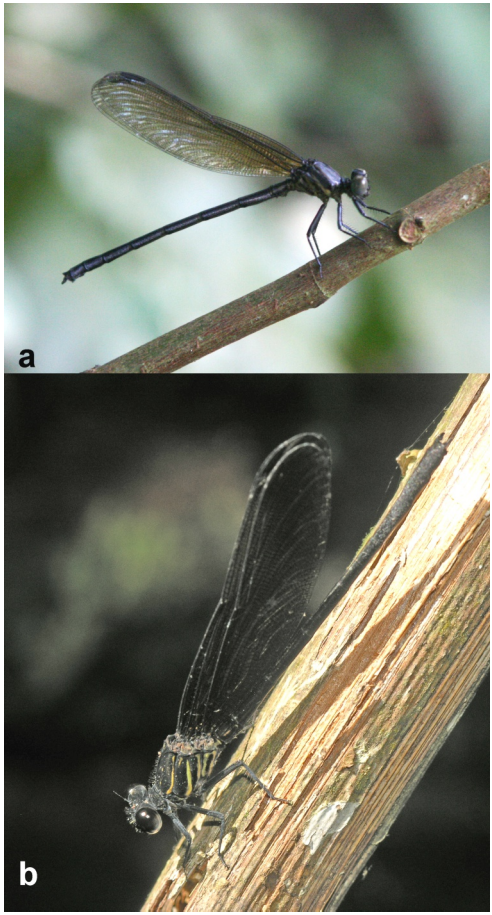

Figure 5. Teneral (a) and mature (b) males of *Euphaea cyanopogon* at Kbal Chhay Waterfall, 9.11.2018.

Further studies in this area are needed.

Interestingly, the genus *Libellago* is represented here by *L. lineata* (Burmeister, 1839) only (Fig. 7) while only *L. hyalina* (Selys, 1859) is found in Ream Peninsula (see below) which is just 20 km SSE of Kbal Chhay Waterfall. So far, *E. cyanopogon* and *Chalybeothemis fluviatilis* Lieftinck, 1933 have been found in Cambodia only at this site.

Of interest were observations of *Z. iris malayanum*. At the end of the day 6.03.2017, at ca. 16 p.m., about 20 flying individuals were observed to form a loose swarm (perhaps feeding behaviour) over the rocky river bed immediately upstream the waterfall, which slowly moved several metres up and down, descending not lower than 3 m above the river. A single individual of *Tholymis tillarga* (Fabricius, 1798), with a characteristic 'jumpy' flight style, participated in this swarm. In contrast, at midday on 10.03.2017, several individuals, perhaps territorial males, of *Z. iris* flew very low over fast water just below the waterfall, and only two of them were observed soaring very high.

New data from Ream Peninsula

The Peninsula was examined for Odonata on 20.04.2010 (Kosterin 2010), 27.05.2013 (Kosterin 2014), 25-27.03.2015 (Kosterin 2015a), 3-5.03.2017 and 10-11.2018 (this paper) (ten days in total). The data of 2010-2015 are summarised in a locality-wise manner in Kosterin (2015a), so Table 2 below contains just a column 'previous data' pooling all earlier records of Odonata for all dates and localities of Ream Peninsula, indicating the maximum abundance grade observed at any of them. The new data obtained on 3-5.03.2017 and 10-11.11.2018 are provided in Table 2 in a locality-wise manner. The ten localities studied in 2010-2015 are coded in Kosterin (2015a) as R1-R10, mostly

Figure 6. Copula of *Orthetrum glaucum* at a shallow pool on a sandstone plate below Kbal Chhay Waterfall, 9.11.2018.

Figure 7. A subteneral male of *Libellago lineata* at the left bank of the Prek Teuk Sap River 1 km downstream Kbal Chhay Waterfall (locality KC5), 9.11. 2018.

along the main road from north-west to south-east. Some of these localities were examined also in 2017 and 2018 and for consistency I retain the same designations (and provide the coordinate ranges for the areas actually examined in these years), but have to add more out of geographical order for newly examined localities. Here is the list of localities examined in 2017 and 2018, arranged in the geographical order (from north-west to south-east), with new localities (R11-R15) interspersing the old ones (R2-R9):

R2. A rivulet at the hilly ridge crossing the road between Ream village and the Ream National Park border, 3.3. km SSW of Ream village. Upstream the road it flows between a plantation and a logged area, slow, ankle to knee-deep, enclosed by fork fern thickets, low trees and rattans, further upstream passes big rocks, then flows, easily permeable, in an even bed with small ground bluffs, shaded by tall trees. Downstream the road it first flows openly over broad sandstone plates with small sedgy seepages (Kosterin 2015a: fig. 4a); further downstream it flowed in March 2017 through partly logged and burned forest among fork fern 'walls', but in November 2018 through already completely barren terrain, 10.5565-5586 N, 103.6560-6599 E, 16-24 m a.s.l., 3.03.2017 and 11.03.2018.

R11. A very small, overgrown, hardly permeable rivulet, somewhat dammed to waist-deep by the road embankment, at the hilly ridge; large 'monument' rocks nearby, 4 km SSW of Ream village, 10.5512-5515 N, 103.6555-6558 E, 32 m a.s.l., 5.03.2017.

R12. A swamp with thin dead (old burnt) forest at a small rivulet (R3 in Kosterin (2015a) is the same rivulet downstream); the water of variable depth, with *Utricularia* spp. with yellow and white flowers; the bottom partly muddy, partly firm with patches of *Eleo-*

Figure 8. A swamp in place of an old burnt area 10.2 km SE of Ream village (locality R13), 5.03.2017.

charis sp. and *Cyperus* sp.; primary forest behind (Fig. 8), 6.3 km SSW Ream, 10.5322-5325 N, 103.6674-6676 E, 10 m a.s.l. Examined on 3.03.2017, in November 2011 exterminated completely as the forest was being logged and burnt.

R6. A rivulet in a dense primary forest crossing the road, upstream the road dammed to a long chest-deep shady pool; downstream the road it flows moderately fast, with some knee- to chest-deep pools, in a valley with low earthen bluffs at sides, shaded, with some sunny places (Kosterin 2015a: fig. 6; Kosterin & Kompier 2018: fig. 9); a small cleared area with a plantation at a distance downstream. The richest locality as to Odonata in March 2015, March 2017 and November 2018 (but surprisingly poor in May 2013, see Kosterin 2014) deserving further studies, the type locality of *A. valentini*. However, in November 2018, the forest was completely logged and burnt at its right bank, with dead tree crowns piled into the rivulet valley, while on the left bank the forest was being logged during our visit. 8.6 km SE of Ream, 10.5213-5244 N, 103.6956-6958 E, 16-20 m a.s.l., 4-5.03.2017 and 10-11.11.2018.

Figure 9. A swampy forest rivulet in Ream National Park (locality 8), a habitat of *Onychargia atrocyana*, 4.03.2017.

Figure 10. The 'Golden Silver Beach' in Ream National Park, 4.03.2017; on that date a place of occurrence of *Potamarcha congener, Lathercista asiatica, Orthetrum sabina, Gynacantha subinterrupta, Urothemis signata, Diplacodes trivialis*.

R7. A rivulet in a dense primary forest crossing the road and forming downstream the road a very large stagnant sunny knee-deep pool with a black bottom, warm water, fine spike-rush (*Eleocharis*) and other sedges, and bush and fork fern thickets at banks (Kosterin 2015a: fig. 7). 8.9 km SE of Ream. 0.5242-5246 N, 103.6982-6984 E, 19 m a.s.l., 5.03.2017 and 10.11.2018.

R13. An open shallow swamp in place of an old burnt area at a rivulet, with firm white bottom, fine sedges, dead trees and further with thickets of a tall semi-aquatic ginger and *Pandanus* sp., 10.2 km SE of Ream village, 10.5175-5180 N, 103.7090-7095 E, 18 m a.s.l., 5.03.2017.

R14. The remarkable Big Tree of Ream and a shady overgrown ground

road towards it through evergreen forest, a small temporarily dry brook in several dozen metres from it, 10.5240-5244 N, 103.7119-7122 E, 33-34 m a.s.l., 10.11.2018.

R8. A swampy rivulet crossing the road; downstream forming a waist-deep pond with sticky red ground banks with some spikerush, upstream forming a long, almost still reach of variable depth crossed by many fallen trees, with tall semiaquatic ginger (Fig. 9; Kosterin 2015a: fig. 8b). 10.7 km SE of Ream, 10.5174-5176 N, 103.7150-7157 E, 19-20 m a.s.l., 4.03.2017 and 11.03.2018 (not yet affected by logging).

R9. The beach, officially called 'Golden Silver Beach' and unofficially 'Chinese Beach', with a primary forest facing the white coral sandy beach (Fig. 10). Some holes 1-2 m in diameter with black mud and with or without water in the forest, the closest just 20 m off the sea. (The small rivulet estuary this time not examined.) 10.500-501 N, 103.721-724 E, at sea level, 4.03.2017 and 10.11.2018.

Figure 11. A grassy swamp at 'Coconut Beach' (locality R15), 11.11. 2018.

R15. A grassy swamp, mostly with tall *Cyperus* sp. but with open water with *Nymphoides indica* (L.) Kuntze (Fig. 11 below) and a broad zone of very shallowly inundated grass alternating with bushes overgrown with Lygodium sp. climbing fern and *Nepenthes mirabilis* (Lour) Rafarin (Fig. 11 above), situated at a margin of a savannah-like area on poor sandy soil (loc. 'veal') just at the so-called Coconut or 'Korean' Beach, 10.4999-5004 N, 103.6506-6514 E, 7-12 m. A promising and still untouched but insufficiently examined habitat deserving further studies, 11.11.2018.

Nineteen species (one identified by exuvia only to genus), namely *Rhinagrion viridatum* Fraser, 1938, *Lestes concinnus* Hagen in Selys, 1862, *Aciagrion* hisopa (Selys, 1876) (identified by a teneral female preserved in alcohol, needs further confirmation), *A. pallidum* Selys, 1891, *Agriocnemis femina* (Brauer, 1868), *A. nana*, *Amphicnemis valentini* (described by the materials of the 2017 trip, see Kosterin & Kompier 2018), *Ceriagrion malaisei* Schmidt, 1954, *Mortonagrion falcatum* Lieftinck, 1934 (already reported from this trip by Kosterin 2018), *Gynacantha demeter* Ris, 1911 (Fig. 12), *G. subinterrupta* (Fig. 13), *Epophthalmia* sp., *Acisoma panorpoides* Rambur, 1842, *Diplacodes nebulosa* (Fabricius, 1793), *Lathrecista asiatica* (Fabricius, 1798), *Onychothemis testacea* Laidlaw, 1902, *Rhyothemis phyllis* (Sulzer, 1776), *R. variegata* (Linnaeus, 1763), *Tholymis tillarga* (Fabricius, 1798), appeared new for Ream Peninsula.

In 2010, I collected two females of *Onychargia* sp. at Ream Recreation Centre and reported them as a male and female (sic) of *Onychargia atrocyana* Selys, 1865 (Kosterin 2010). Later I described from Cambodia the second species of this genus, *O. priydak* Kosterin 2015, but failed to find its diagnostic characters in females (Kosterin 2015b), so the identity of the Ream females became uncertain. Now I can confirm *O. atrocyana* (Fig. 14) for Ream Peninsula, as expected (two localities). It was curious to observe a male and female to rest on the same ginger leaf without obvious connection between them (Fig. 14 below).

On 10.11.2018, several individuals of *G. demeter* were startled from low (not more than 10-20 cm above the ground) thin branches of bushes at sides of a shady ground road going through the forest towards the Big Tree. They flew low above the ground for some distance and sat, being easy to catch or photograph (Fig. 12). In this habit they differ from the much more common *G. subinterrupta* which also do not fly for long at daytime even startled but invariably prefer higher, about human height perches.

It was surprising to find on the last, fifth visit of Ream Peninsula (10-11.11.2018) a conspicuous species not seen before: several individuals of *O. testacea* were met at the richest locality of R6. It is more habitual to see this species at powerful streams with riffles very unlike the small and smooth rivulet. However, these dragonflies demonstrated their usual habits: perching on dry branches over a fast reach, fighting each other and preferring to hunt for butterflies, these behaviours were again observed and registered (Fig. 15).

It was curious to find (in sedges at the sandstone plates of a rivulet valley, together with *L. concinnus* and *A. borneense*) quite a lot of *A. femina*, rather rare in Cambodia, but only few usually common and omnipresent *A. pygmaea*. The only specimen of *M. falcatum*, an immature male, was collected in a tandem with a male of *C. vittata*, showing attempts to form a copulation wheel (Kosterin 2018). For some reason no *Euphaea* has so far been found in Ream Peninsula, in spite of the presence of riffles at least at a rivulet of R2.

Figure 12. A male of *Gynacantha demeter* at a shady forest road near the Big Tree of Ream (locality R14), Ream National Park, 11.11.2018.

Figure 13. A male of *Gynacantha subinterrupta* in forest shade at a rivulet of locality R2 upstream the road, 3.03.2017.

Both presumed *Macromia* sp. and *Hemicordulia tenera* Lieftinck, 1930, tentatively recognised for the general habitus and characteristic flight, were for a very short time observed at 11:40 and 12:00, respectively, over the shaded water of the rivulet of locality R6 on 4.03.2017. Analogously, on 10.11.2018 another *Macromia* sp. swiftly

Figure 14. A male (right) and female (left) of *Onychargia atrocyana* at a swampy forest rivulet of locality R8 and figure 9 in Ream National Park, 4.03.2017.

passed by over the rivulet and a Gomphidae indet. landed on a small palm frond but both could not be caught. There seems to be only one chance to encounter any rare lotic dragonfly per day spent in that rivulet and it would be necessary to visit it each day for some two to three weeks to reveal the fauna - but that is no longer possible because of the forest logging.

The open pool of the rivulet of R7 confirmed (after the report by Kosterin 2015a) to be a place of co-existence of *P. australasiae* Selys, 1876 and *P. microcephalum* (Rambur, 1842) (very similar in appearance, the former slightly larger), on 10.11.2018 the former being about twice as abundant.

Loc. R9 is the only place I have seen on the earth so far where a lush virgin evergreen tropical forest immediately faces an almost wild beach of white coral sand (Fig. 10) (the 'Golden Silver Beach', or Chinese beach). (There is little hope that at least a narrow strip of that forest will remain for near future.) On 4.03.2017, I was surprised to see numerous and rather diverse dragonflies at the forest margin (with participation of *Pandanus* sp. and some trees of *Melaleuca cajuputi* Powell) facing the beach on a considerably windy evening, ca. 16:40-17:20. An enormous number of *P. congener* perched at branch tips. I also met two bright males of *L. asiatica* and a male of *Orthetrum sabina* (Drury, 1773). Some *Diplacodes trivialis* (Rambur, 1842) landed on the sand in front of the forest

Figure 15. A male of *Onychothemis testacea* eating *Eurema* sp. at the forest rivulet of locality R6, 11.11.2018.

margin, and a quite unexpected male of *Urothemis signata* (Rambur, 1842) perched on grasses. (At least the larvae of *P. congener*, *O. sabina* and *U. signata* tolerate some brackish water; in May 2013, too, I found a female of a well-known brackish water species, *Macrodiplax cora* (Kaup in Brauer, 1867) at the same beach, see Kosterin 2014). Inside the forest but close to the margin I found two ground holes with black mud, 1-2 m in size, one of which just 20 m from the shoreline. Each of them was patrolled by a quickly ranging male of *G. subinterrupta* (observed at 16:45 and 17:05, both captured and checked). On 10.11.2018, the coast was still intact but the only Odonata observed there were *Brachythemis contaminata* (Fabricius, 1793), not seen on the 2017 visit.

To sum up

The total number of species of Odonata known and identified for the Kampong Saom Peninsula in general, which can be counted from Tables 1 and 2 altogether, has reached 74. The data were obtained in spring, from March to May, and November. With only 3 identified species of Aeshnidae, 1 of Gomphidae, none of Macromiidae registered and at least 7 unidentified species observed (3 of Gomphidae and 2 of Macromiidae, 1 probably of Corduliidae and 1 of *Tetrathemis*), the fauna revealed is surely still incomplete, and will have to remain so forever because of the ongoing

murder of local nature. Although dry season species *A. pallidum* and *L. asiatica* were found, this peninsula, as protruding into the sea, is perhaps less affected by the winter monsoon and more humid during the conventional dry season than the rest of Cambodia and now provided quite diverse Odonata assemblages even in March and April, the poorest months elsewhere. Although the seasonality may be not so well expressed here, presently one can only guess what summer would provide.

New data from Koh Rong Island

After my first visit to Koh Rong in late dry season in March 2015 I reported 17 Odonata species for the island (one of them added by a photo of another author) (Kosterin 2015a). On the 2017 visit I found 12 species of Odonata, four recorded for the first time for the island: *C. olivaceum*, *B. contaminata*, *O. sabina* and *M. cora* (all but the last one common in Cambodia). This elevated the number of odonate species known from Koh Rong to 21.

A female of *C. olivaceum* was found on 9.03.2017 on an old felled area with saplings of regenerated forest at the small 'Windy Stone' pass between the main settlement in the south-western bay and the western end of the Long Beach on the north-western coast.

The four other species were found on the same day at the best locality for lotic dragonflies found in the island still in the 2015 visit, designated KR4 in (Kosterin 2015a, see fig. 13 there): a 150 m long, knee-deep freshwater channel with a muddy bottom along the Long Beach, 10°42'12-14" N 103°14'45-48", 9 m a.s.l. Two males (one collected) of *M. cora* patrolled the channel and perched on high solitary grasses, several males of *O. sabina* were found at banks; one of which teneral, with still glittering wings only one male of usually numerous *B. contaminata* flew along the bank, and in grass and over the surface there were many males and tandems of *P. microcephalum*. Of other species: *I. senegalensis*, *D. nebulosa* were present at that locality on both 2015 and 2017 visits, *N. fluctuans* only found in 2015 and *D. trivialis* (one not pruinose individual) only in 2017.

Morphological and taxonomic notes

The female of *C. malaisei* collected at R13 (where a male was also collected) has a somewhat unusual mesostigmal plate (Fig. 16). The lateral carinae are oblique, which is a characteristic feature of *C. malaisei* (Asahina 1967), but the lateral black depressions are not expressed while there is a pair of curious swellings behind the acrotergite posterior ridge. More specimens are needed to judge if these peculiarities are of some value.

Gynacantha demeter was described from Borneo (Ris 1911) as differing from *G. dohrnii* Krüger, 1899 (found on the same island), with the only sound character of relatively shorter cerci: ca. 350% as long as S10 in *G. demeter* vs. ca. 415% in *G. dohrnii* (see Asahina 1986: figs 73-75). The validity of *G. demeter* was repeatedly doubted. The measurement of the cerci of a male specimen from Cambodia (Koh Kong Province, Tatai Commune) provided the result of 380% that was considered as corresponding to *G. demeter* (Kosterin & Chartier 2018). The specimen now collected at the Big Tree of Ream has cerci 395% as long as S10, which is rather intermediate between the two presumed

Figure 16. Mesostigmal plate of a female of *Ceriagrion ?malaisei* collected at locality R13 on 3.03.2017. Scale bar 0.5 mm.

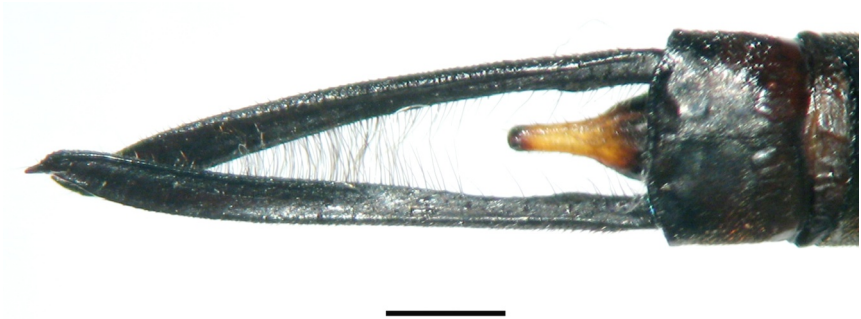

Figure 17. Anal appendages of a male of *Gynacantha demeter* (identification conventional, see the text) collected at the Big Tree of Ream (locality R14) on 10.11.2018. Scale bar 1 mm.

species. This rises again the question of their possible conspecificity. So, herein I apply the name *demeter* to this specimen rather conventionally. Anyway, the problem of two versus one species is to be solved in Borneo from where both were described.

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Appendices

Table 1. Odonata found in the Kbal Chhay Waterfall surroundings on 19.04.2010 (Kosterin 2010), June 2013 (Kosterin 2014) March 2017 and November 2018 (this paper). Codes of abundance: - – not found, – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals), 3 - moderately abundant (6-20), 4 – abundant (~20-100); underlining indicates that specimen(s) was (were) collected at this locality, boldface – that the species was photographed.

locality	KC1			KC2		KC3		KC4	KC5			KC6				KC7	
month and year	v 2013	iii 2017	Xi2018	v 2013	iii 2017	iv 2010	iii 2017	v 2013	v 2013	iii 2017	xi 2018	v 2013	iii 2017	xi 2018	v 2013	iii 2017
taxon																
Calopterygidae																
1. *Vestalis gracilis*	-	-	3	-	-	2	4	-	1	4	3	-	-	-	-	-
Euphaeidae																
2. *Dysphaea gloriosa*	-	-		-	-	-	-	-	2	-	-	-	-	-	-	-
3. *Euphaea cyanopogon*[1]	-	**3**	**3**	-	-	1♀	**2**	-	-	-	**3**	-	-	-	-	-
Chlorocyphidae																
4. *Heliocypha biforata*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. *Libellago lineata*	-	3	-	-	-	-	-	-	1♂	3	**2**	-	-	-	-	-
Coenagrionidae																
6. *Agriocnemis minima*	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	
7. *Agriocnemis nana*	-	-	-	-	-	-	-	-	-	-	-	-	2♂	-	-	-
8. *Agriocnemis pygmaea*	-	-	-	-	-	-	-	-	-	-	-	-	1♂	-	-	1♂
9. *Aciagrion borneense*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1♀
10. *Archibasis viola*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
11. *Ceriagrion cerinorubellum*	-	-	-	-	-	-	-	3	-	1♂	-	-	-	3	-	-
12. *Ceriagrion olivaceum*	-	-	-	-	-	-	-	-	-	-	-	-	1♀	-	-	-
13. *Paracercion calamorum*	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
14. *Pseudagrion australasiae*	-	-	-	2	-	2	2	-	-	2	-	1♂	3	3	1♂	1♂
15. *Pseudagrion rubriceps*	-	-	-	2	-	2	-	-	-	1♂	-		1♂	-	1♂	1♂
16. *Pseudagrion willamsoni*	-	2	-	-	2	2	2	1♂	-	3	-	-	-	3	-	-
Platycnemididae																
17. *Copera vittata*	-	1♂	2	-	-	-	-	-	-	-	1♂	-	-	-	-	-
18. *Prodasineura autumnalis*	-	-	-	-	-	-	-	-	-	1♂	1♂	-	-	-	-	-
19. *Prodasineura verticalis sensu* Asahina, 1984	-	2	-	-	-	-	-	-	1♂	2	2	-	-	-	-	-
20. *Pseudocopera ciliata*	-	-	-	-	-	-	-	4	-	1♂	-	-	-	-	-	-
Aeshnidae											-					
21. *Anax guttatus*	-	-	-	-	-	-	-	1♂	-	-		-	-	-	-	-
22. *Gynacantha subinterrupta*	-	-		-	-	♀1	-	-	-	-	1♂	-	-	-	-	-
Gomphidae											-					
23. *Ictinogomphus decoratus melaenops*	-	-	-	1♂	-	-	-	3	1♂	-		3	-	=	3	-
Gomphidae indet.	-	-		-	-	-	-	-	-	1		-	-	-	-	-

[1] All the specimens collected contributed to the type series, including the holotype.

locality	KC1			KC2		KC3		KC4	KC5			KC6			KC7	
month and year	v 2013	iii 2017	Xi2018	v 2013	iii 2017	iv 2010	iii 2017	v 2013	v 2013	iii 2017	xi 2018	v 2013	iii 2017	xi 2018	v 2013	iii 2017
taxon																
Synthemisidae											-					
24. *Idionyx thailandica*	-	-	-	1♂	-	-	-	-	-	-		-	-	-	-	-
Macromiidae																
Epophthalmia sp.	-	-	-	-	1	-	-	-	2	1	1♂	**4(exuv.)**	-	-	-	-
Libellulidae																
25. *Acisoma panorpoides*	-	-	-	-	-	-	-	1♂	-	-	-	-	-	-	1♂	-
26. *Brachydiplax chalybea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
27. *Brachygonia oculata*	-	-	-	-	-	-	1♀	-	-	-	-	-	-	-	-	-
28. *Brachythemis contaminata*	-	-	-	-	2	**2**	2	-	3	-	-	2	-	1♂	-	2
29. *Chalibeothemis fluviatilis*	-	-	-	-	-	-	-	**2**	-	-	-	1	-	-	2	-
30. *Diplacodes nebulosa*	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-
31. *Diplacodes trivialis*	-	-	-	-	2	-	-	-	-	-	1♂	-	-	-	-	-
32. *Lathrecista asiatica*	-	**2**	-	-	-	1♂	-	-	-	**1**♂	-	-	-	-	-	-
33. *Neurothemis fluctuans*	-	-	-	1♂	-	-	3	-	2	4	1♂	-	-	3	3	-
34. *Neurothemis fulvia*	-	-	-	-	1♂	-	-	-	-	-	-	-	-	-	-	-
35. *Neurothemis tullia*	-	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-
36. *Onychothemis testacea*	-	-	-	-	-	-	-	-	1♀	-	1	-	-	-	-	-
37. *Orthetrum chrysis*	-	2	3	-	2	-	2	-	2	**3**	3	-	-	-	-	-
38. *Orthetrum glaucum*	-	**1**♂	**2**	-	-	-	-	-	-	1♂	2	-	-	-	-	-
39. *Orthetrum neglectum*	-	-	-	-	2	-	-	-	-	**2**	1♂	-	-	-	-	-
40. *Orthetrum sabina*	-	3	-	1♂	3	-	2	-	-	3	2	2	2	-	1♂	2
41. *Pantala flavescens*	-	2	2	-	-	-	-	-	-	-	4	-	-	-	-	-
42. *Potamarcha congener*	-	-	-	-	-	-	-	-	-	**2**	-	-	-	-	-	-
43. *Rhodothemis rufa*	-	-	-	-	-	-	-	-	-	1♀	-	-	1♂	-	-	-
44. *Rhyothemis obsolescens*	-	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-
45. *Rhyothemis phyllis*	-	2	1♀	1♂	-	-	2	2	-	3	1	-	1	1	2	2
46. *Rhyothemis variegata*	-	-	-	1♂	-	-	-	-	-	1♀	-	1♀	-	-	-	-
47. *Tholymis tillarga*	-	1	-	-	-	2	-	-	-	-	2,all♀	-	-	1♀	-	-
48. *Trithemis aurora*	-	2	-	-	2	**2**	2	-	-	3	1♀	-	-	-	-	-
49. *Trithemis festiva*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
50. *Trithemis pallidinervis*	-	-	-	-	-	-	-	-	-	-	-	3	2	-	3	**2**
51. *Urothemis signata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
52.*Zygonyx iris*	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
53. *Zyxomma petiolatum*	-	-	-	-	-	-	**1**♂	-	-	-	-	-	-	-	-	-

Table 2. Odonata found in Ream Peninsula, Preah Sihanouk Province of Cambodia: previous data of 2010-2015 (Kosterin 2015a) pooled up and new data of 3-5.03.2017 and 10-11.11.2018 for localities R2-R13 (see the text). Column 8 shows data of 2017. Codes of abundance: - – not found, 1 – single individual found (sex indicated when clear), 2 – few (2 to 5 individuals), 3 - moderately abundant (5-20), 4 – abundant (~20-100), 5 – very abundant (>>100); underlining indicates that specimen(s) was (were) collected at this locality, boldface that the species was photographed.

Species	previous	R2		R11	R12	R6		R7		R13	R14	R8		R9	R15
iii 2017 or xi 2018		2017	2018	2017	2017	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
taxon															
Calopterygidae	3	4	3	3	-	5	5	3	-	-	2	-	-	-	-
1. Vestalis gracilis															
Chlorocyphidae	4	-	2	-	-	-	-	-	-	-	-	-	-	-	-
2. Heliocypha biforata															
3. Libellago hyalina	**4**	4	-	-	-	5	5	3	-	-	-	-	-	-	-
Phylosimidae	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	
4. Rhinagrion viridatum															
Lestidae	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Lestes concinnus															
Coenagrionidae	1♂	1♀	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Aciagrion borneense															
7. Aciagrion hisopa	-	=	-	-	-	-	-	-	-	-	-	-	-	-	1♀
8. Aciagrion pallidum	-	=	-	-	-	1♂	-	-	-	-	-	-	-	-	-
9. Agriocnemis femina	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
10. Agriocnemis minima	1♂	-	-	-	-	-	1♂	-	-	-	-	-	-	-	4
11. Agriocnemis nana	-	2	-	-	1♂	-	-	-	-	1♂	-	-	-	-	-
12. Agriocnemis pygmaea	2	-	-	-	-	2!	-	-	-	-	-	-	-	-	2
13. Amphicnemis valentini	-	-	-	-	-	4	3	3	-	-	-	-	-	-	-
14. Archibasis viola	4	2	-	-	-	4	3	3	-	-	-	-	-	-	-
15. Ceriagrion cerinorubellum	1♂	2	-	-	1♂	1♂	-	-	-	1♂	-	-	1♀	-	4
16. Ceriagrion malaisei	-	-	-	-	1♂,1♀	-	-	-	-	-	-	-	-	-	-
17. Ceriagrion olivaceum	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Ischnura senegalensis	1♂	-	-	-	-	-	-	3	4	-	-	-	2	-	-
19. Mortonagrion falcatum	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-
20. Pseudagrion australasiae	2	-	-	3	2	-	3	4	-	-	-	3	-	-	-
21. Pseudagrion microcephalum	4	=	2	-	-	-	-	-	4	-	-	-	2	-	-
22. Pseudagrion rubriceps	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23. Pseudagrion willamsoni	1♂	2	3	2	1♂	-	-	3	2	-	-	2	3	-	-
Platycnemididae	2	1♂	-	-	-	4	4	-	-	-	-	-	-	-	-
24. Copera vittata															
25. Coeliccia kazukoae	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26. Onychargia atrocyana	2	-	-	-	-	=	-	1♂	-	-	-	**2**	2	-	-
27. Pseudocopera ciliata	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28. Prodasineura verticalis ser-su Asahina, 1984 nec Selys 1860	2	3	1♀	-	-	2	4	-	2	-	2 (♀♀)	-	-	-	-
Aeshnidae	-	-	-	-	-	-	-	-	-	-	2 (♂♂)	-	-	-	-
29. Gynacantha demeter															
30. Gynacantha subinterrupta	-	**2**	-	-	-	-	-	-	-	-	-	-	-	2	-
Gomphidae	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gomphidia sp.															
Gen. sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

Species	previous	R2		R11	R12	R6		R7		R13	R14	R8		R9	R15
iii 2017 or xi 2018		2017	2018	2017	2017	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
taxon															
31. *Ictinogomphus decoratus melaenops*	1	-	-	-	-	-	-	-	2	-	-	-	2	-	-
Macromiidae (?*Macromia* sp.)	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
Epophthalmia sp.	-	-	-	-	1 exuv.	-	-	-	-	-	-	-	-	-	-
?Corduliidae (?*Hemicordulia tenera*)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Libellulidae 32. *Acisoma panorpoides*	-	-	-	-	2	-	-	-	-	-	-	-	-	-	4
33. *Brachygonia oculata*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34. *Brachythemis contaminata*	1	-	-	-	-	-	-	-	-	-	-	-	-	3(2018)	-
35. *Brachydiplax chalybea*	**1**	-	-	2	1♂	-	-	-	3	2	-	2	-	-	4
36. *Cratilla lineata calverti*	1♀	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37. *Crocothemis servilia*	1♂	-	-	-	-	-	-	-	-	-	-		-	-	-
38. *Diplacodes nebulosa*	-	-	-	2	5	-	-	3	-	-	-	-	-	-	3
39. *Diplacodes trivialis*	2	-	-	-	-	-	-	-	-	-	-	-	-	2	-
40. *Hydrobasileus croceus*	2	-	-	-	-	-	-	1♂-	-	-	-	-	-	-	-
41. *Lathrecista asiatica*	-	1♂	-	-	-	-	-	-	-	-	-	-	-	2	-
42. *Macrodiplax cora*	1♀	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43. *Nannophya pygmaea*	4	-	-	-	2	-	-	2	4	3	-	3	3	-	-
44. *Neurothemis fluctuans*	4	5	2	3	4	5	5	4	4	4	-	4	3		4
45. *Neurothemis tullia*	2	-	-	-	-	-	-	-	1♀	-	-	-	-	-	3
46. *Onychothemis testacea*	-	-	-	-	-	-	**2**	-	-	-	-	-	-	-	-
47. *Orchithemis pulcherrima*	1	-	-	-	-	-	-	-	-	-	1♂juv.	-	-	-	-
48. *Orthetrum chrysis*	**3**	3	3	3	-	2	1♀	3	1♂	2	-	4	3	-	-
49. *Orthetrum neglectum*	**2**	-	1♂	-	-	-	-	-	-	-	-	-	-	-	-
50. *Orthetrum sabina*	2	1♂	1	-	-	1♂	4	-	3	2	-	2	3	1♂	-
51. *Pantala flavescens*	1	1	-	-	-	-	3	-	1	-	-	-	1	-	-
52. *Potamarcha congener*	1	1♀	-	-	-	1♂	-	-	-	-	-	-	-	5	**1**♂
53. *Rhodothemis rufa*	1♀	-	-	-	-	-	-	-	1♂	-	-	1♂	-	-	-
54. *Rhyothemis obsolescens*	**2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55. *Rhyothemis phyllis*	-	1	2	-	-	-	5	2	2	-	-	1	-	-	4
56. *Rhyothemis variegata*	-	-	-	-	-	-	5	-	-	-	-	-	-	-	4
Tetrathemis sp.	1	-	-	-	-	-	4	-	1♂	-	-	-	-	-	-
57. *Tholymis tillarga*	-	1♀	-	-	-	-	-	-	-	-	-	-	-	-	-
58. *Trithemis aurora*	2	1♂	-	-	-	-	-	-	-	-	-	-	-	-	-
59. *Trithemis festiva*	1♂	-	-	-	-	-	-		-	-	-	-	-	-	-
60. *Trithemis pallidinervis*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61. *Urothemis signata*	3	-	-	-	-	-	-	1♂	1♂	-	-	1♂	2	1♂	-

The holotype and three of the paratypes.

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